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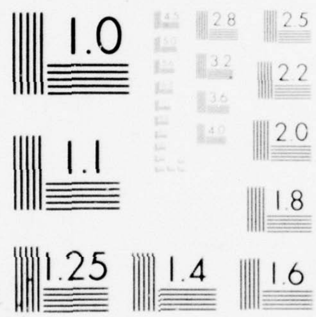

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TAEG REPORT
NO. 41

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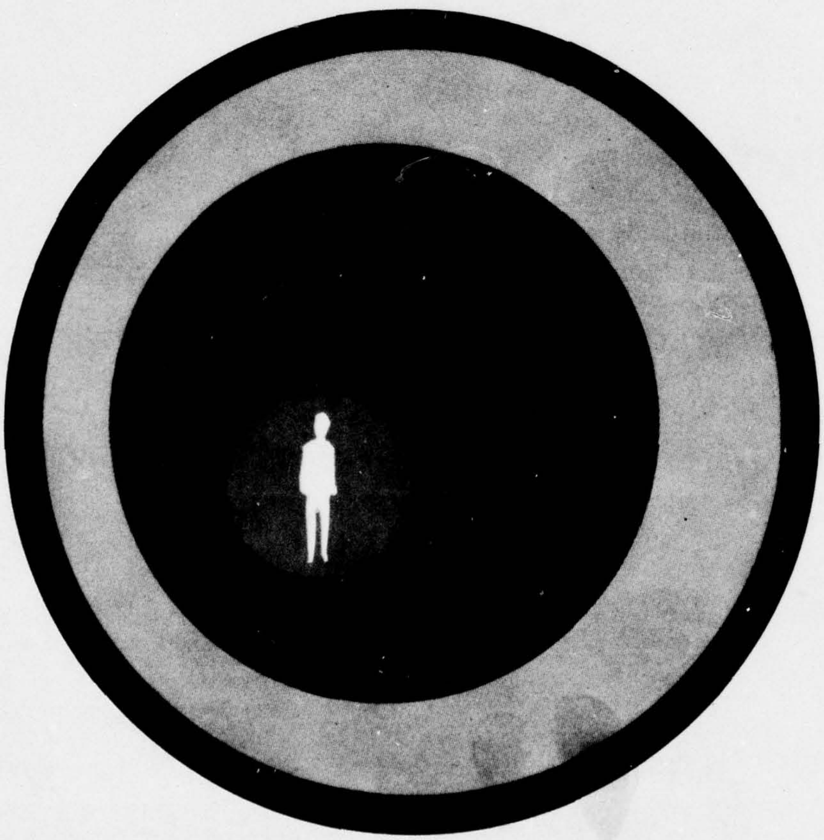

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Through unstructured interviews the elements of knowledge and skill required of a competent ship handler were identified. Personal characteristics inherent in all ship handlers were defined.

From analyses of 196 Navy and Merchant Marine accidents the environmental and human factors which contributed to these accidents were determined. Two special cases, wake damage and replenishment at sea, were also investigated.

20. ABSTRACT (continued)

An inspection of existing training and training devices was made to ascertain deficiencies therein.

Based on a series of analyses of the elements, causative factors, and existing training, a new training system was proposed. Aids and devices, in addition to those already in existence, were suggested.

This study identified areas wherein additional studies are required. The system proposed can be implemented concurrent with the suggested additional studies.

TAEG Report No. 41

SHIP HANDLING
AND
SHIP HANDLING TRAINING

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December 1976

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SECTION I

INTRODUCTION

This study is concerned with ship handling and ship handling training. These areas have not been emphasized by the Navy in assessing its posture for the post 1980's. Ship handling has not come under scrutiny consistent with forseeable needs nor has the training of ship handlers taken advantage of the available instructional technology. The major concepts of ship handling currently in vogue need reexamination. To solve the persistent problems in these two areas, an assessment of ship handling is being performed.

The development of a cohesive ship handling training system has been inhibited by a number of circumstances. First, ship handling has not been analyzed and defined in specific terms which can be converted to learning objectives. The imprecise, contemporary thinking regarding ship handling is illustrated in an authoritative source. "Ship handling is the highest form of seamanship. It is an art because the forces involved are so many, so variable, and so different from ship to ship, under all conditions of wind and sea" (Knight, 1966). In the operational context, mariners loosely use the term ship handling to describe evolutions which require the person directing the vessel to order it maneuvered to avoid an incident or accomplish a mission.

Second, ship handling training has been, primarily, on-the-job and dependent upon operational steaming during which ship handling evolutions were performed. Recent research by the Center for Naval Analyses (Mann, 1973) during high tempo operations indicates that only 40 percent of the time was spent underway. The most frequent evolution, entering and leaving port, occurred once every 4.9 underway days, and the least frequent, anchoring, once every 39.8 underway days. The opportunity for individual junior officers (JO's) to handle the ship during evolutions required by the Personnel Qualification Standards (PQS) to qualify as Fleet Officer of the Deck (OOD(F)) occurred, with one exception, less than once a year. The available opportunities for JO's to ship handle have been further reduced because underway operational readiness training time has been cut to an average of 17 days per quarter per ship.

Last, ship handling is not a completely procedural task. Consequently, the application of the requisite knowledges, skills, and behaviors associated with ship handling do not lend themselves to simple step-by-step procedures although attempts have been made to make it so. Schumacker, Madsen, and Nicastro (1972) state that, "Unlike flying an aircraft when specific instructions are issued and followed on how to perform every maneuver, ... ship handling to a much larger extent is an acquired art."

The foregoing indicates the need for a comprehensive analysis of ship handling in order to define the concepts and procedures precisely and to serve as a basis for training system design sensitive to both present and future needs.

BACKGROUND

On 9 April 1976 discussions were held between the Director, Training Analysis and Evaluation Group (TAEG) and Chief of Naval Education and Training Support (CNET SUPPORT) personnel concerning ship handling training. The issues discussed were the identification of training requirements, the effectiveness of existing training, and the possible utility of developing a ship handling trainer based on simulation procedures to support the existing training program.

The Chief of Naval Education and Training (CNET) by memorandum Code 00 of 15 April 1976 proposed TAEG as an agent to study the broad question. Accordingly, TAEG was tasked in May 1976 to develop training requirements and a training strategy. In June 1976 the Chief of Naval Operations (CNO) requested that the TAEG study address the means of accomplishing any required changes to existing training, a prioritization scheme for training, and training schedules. The study commenced in July 1976 and was completed in December of the same year.

PURPOSE OF THE STUDY

The purpose of this study was to identify the training requirements for a ship handler and to develop the concept for a career structured training system which incorporates these requirements. In order to accomplish this purpose it was first necessary to identify the knowledge and skill elements which are components of ship handling.

APPROACH

Three categories of information were required to develop an effective ship handling training system which makes maximum use of available facilities and training. The three categories of information were:

1. a definition of ship handling in terms of the knowledge and skills required of a qualified ship handler which includes the related problems of a JO in qualifying, and the perceived need for advanced training;

2. the environmental and human factors which contribute to ship handling incidents; and

3. the scope and depth of existing training.

A literature search for the three categories of required information was conducted. Unfortunately, it provided only minimal information on the first category (knowledge and skill elements required by a ship handler). Consequently, other sources had to be identified and accessed. Investigation located two major commercial ship handling simulators. It was anticipated that the knowledge and skill elements required by a ship handler had been identified and incorporated in the design of these simulators. Therefore, a visit was made to the Computer Aided Operations Research Facility (CAORF), described in the Sperry Systems Management Division System Definition Report (1972), to discuss the elements identified. In addition, personnel at Marine Safety International, owners of the second simulator, were visited to discuss the required knowledges and skills which they had identified and included in their simulator. From these visits it was determined that specific knowledge and skill elements had not been identified.

Since the knowledge and skill elements required of a ship handler had not been identified in the literature or commercial sector, it was necessary to obtain the opinions of subject-matter experts. Thirty-eight activities, thirty-four of them Naval commands, were visited. Ship handling experts were interviewed at each activity. Knowledge and skill elements were identified by consensus. In addition, the Code of Federal Regulations, 46, "Shipping" (1975) were perused and discussed with U.S. Coast Guard officers concerning the qualifying and certifying of Merchant Marine Officers. Appendix A is a list of activities contacted.

The second category of required information, environmental and human factors which contribute to incidents, was obtained from documented reports provided by Navy and commercial sources. Incidents are dangerous or in-extremis situations wherein no damage to either vessel, or personnel injury necessarily occurred. Accidents describe a series of events, decisions, and situations which culminate in injury or damage. Both are closely related to ship handling skills in that proper ship handling techniques may preclude the occurrence of an incident.

Visits were made to the training activities identified in appendix A to determine the extent and depth of existing training, the third required information category. Discussions were held with personnel responsible for the conduct of training, and course material was reviewed. Aids and devices were examined and evaluated.

Three determinations were made from the three categories of information acquired. First, based on the opinions of the interviewees, a definition of ship handling was derived from the elements of knowledge and skill required of a ship handler. Second, the environmental and human factors which contributed to incidents were established. Third, the scope of existing training was determined.

Comparative analyses and a synthesis of these determinations were made to establish the requirements for a training system. The necessary content of the system and the timing of courses with respect to a Naval officer's career progression were established. Figure 1 provides an overview of the study logic. In order to provide a standardization of meanings of terms used in this report, certain definitions were developed and used. A glossary of these definitions is provided in appendix B.

ORGANIZATION OF THE REPORT

In addition to this introduction, five major sections are provided. Section II contains a discussion of the elements of ship handling and introduces the concept of required capabilities for all ship handlers. It contains a listing of the knowledge and skills considered to be the minimum requirements for a qualified ship handler. The discussion also addresses the possible need to identify persons not capable of becoming ship handlers before accepting them into the training pipeline.

Section III presents detailed analyses of the incident data organized in terms of the environment wherein the accident occurred and in terms of the human factors contributing to the incident.

Section IV summarizes the results of the examination of existing ship handling training. The discussion includes the extent of topic coverage at the various schools and the use of existing training aids and devices.

Section V contains a discussion of the proposed training system in terms of course content, course sequencing, training objectives, training priorities, and training aids and devices.

Section VI contains the conclusions and recommendations.

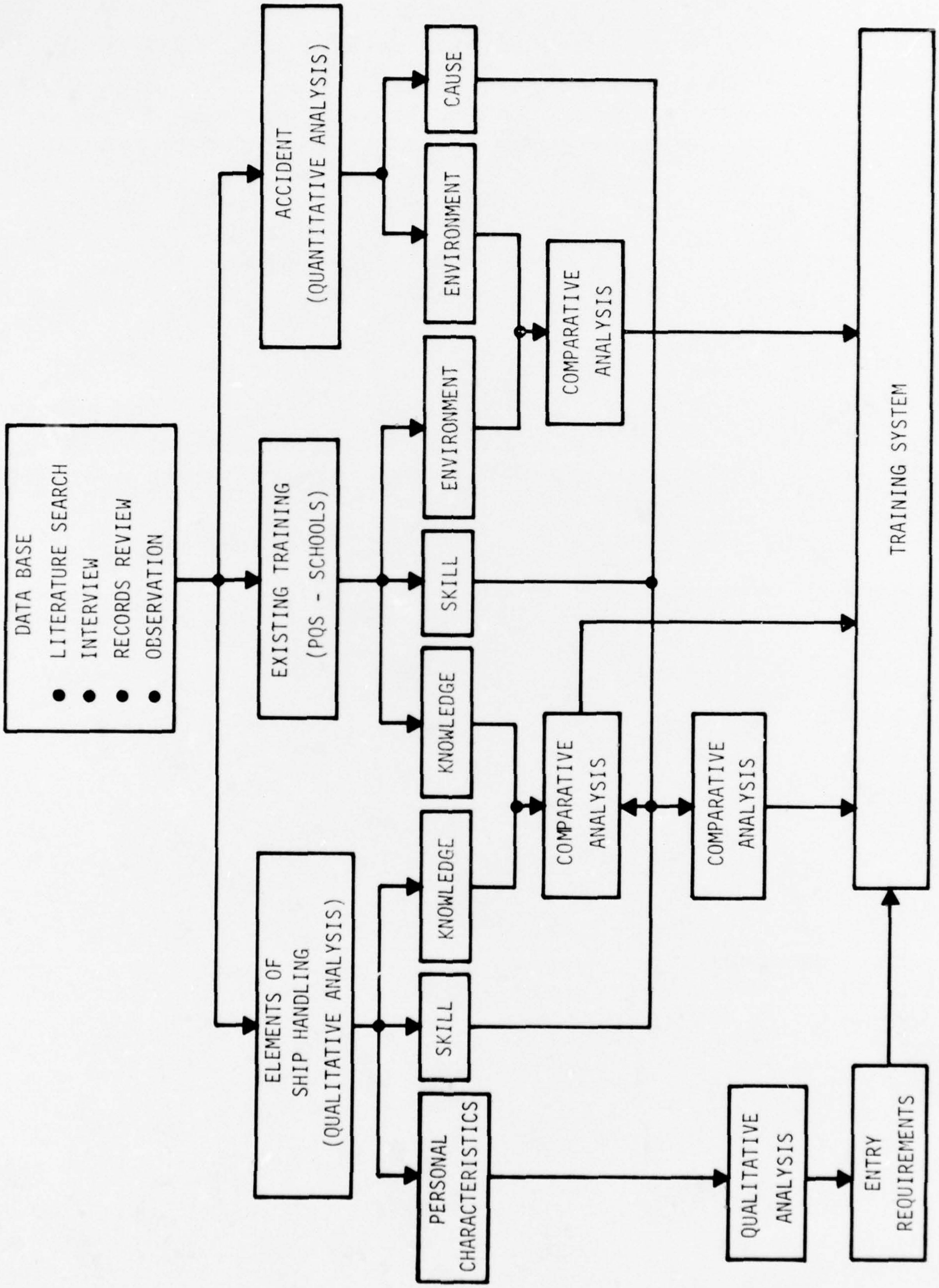


Figure 1. Study Approach

SECTION II

ELEMENTS OF SHIP HANDLING

This section identifies and describes the requisite knowledge and skills of a ship handler. During the process of identifying knowledge and skill elements, a third important element class emerged and was included in the analyses. This class consisted of the personal characteristics required of all ship handlers. In this study personal characteristics refer to a predisposition toward specific behavioral patterns, information processing capability, and attitudes. Personal characteristics are discussed as they relate to a ship handling training system and the selection of JO's for the unrestricted line officer corps. The selection issue is discussed in terms of its impact on CNET.

SUMMARY

A definition for a ship handler is developed. Based on a series of interviews, three types of elements are identified as being required. These are the knowledge and skills required in ship handling situations and those personal characteristics which a conning officer must possess.

Problems associated with the qualifying of JO's are discussed since these problems can be translated into required training. One major problem area is the PQS. All JO's are not subjected to identical or standardized criteria.

The need for advanced training for senior ship handling officers was questioned. It was found that tradition plays a large part in the perceived need for this training. Nonsurface and less experienced qualified surface warfare officers (SWO's) view this training as necessary, while senior SWO's with strong surface ship backgrounds either avoid the issue or reject it.

The discussions highlighted the need for officers to possess and maintain some reliable record of their past OOD experience. This would permit commanding officers (CO's) to make independent assessments of the training needs of their underway conning officers, and the degree to which each officer's experience could be relied upon.

DISCUSSION

For the purpose of this investigation, ship handling was defined as <u>those situations wherein the conning officer is required to make immediate decisions with respect to the maneuvering of the ship, and outside aids; i.e., Combat Information Center, ground tackle (including tugs), navigational aids, etc., are of relatively little value. However, a failure to use outside aids, the improper use of these aids, or the lack of preparation for a situation is considered to be poor ship handling</u>. Ship handling

includes both the situation itself and the actions of the conning officer involved in arriving at an in-extremis or a dangerous position. To illustrate, prior to entering port a ship makes many preparations for the evolution. Presuming all were made correctly, and all available aids to piloting were used properly, then the evolution is a conning situation. As the vessel approaches the pier for a landing, by definition a dangerous situation, the aids become of little or no value, and decisions concerning maneuvering are made on occurrences only. The conning situation has now become a special case; i.e., ship handling.

This definition of ship handling permits a dividing line between the conning and ship handling situations. Ship handling is a subtask of the conning tasks, the master mariner's tasks, and the OOD's tasks in the following ways:

- Ship handling is a specialized case of conning; all conning situations are not ship handling situations.

- Master mariner is an all-encompassing term covering all aspects of seamanship and navigation as well as related subjects. Ship handling is but a small, albeit important, subfunction.

- OOD responsibilities include both administrative and conning tasks. Therefore, ship handling is a small subfunction of the overall position.

METHODOLOGY

Interviews were conducted to determine the elements of ship handling. Questions were posed to senior officers in unstructured interviews. The questions were not made available in advance, and were worded to apply to each specific group in terms of their present duty. A copy of the general guidelines for the interview is included as appendix C. The form and content of the questions varied slightly from group to group as the study team acquired additional data. When ambiguous terms such as "seaman's eye" were used, probing questions were asked in an attempt to establish concise definitions of the terms.

The questions were grouped in three subject areas. These were the identification of the:

- Knowledge and skills required of a ship handler in order to qualify

- Problems of a JO in qualifying

- Advanced training requirements.

A general discussion covering the entire series of questions occurred at the conclusion of each seminar. With two exceptions, the discussions were not constrained by rank although duty station did play a definite role in the types of answers given. Usually a consensus concerning the discussion point was reached. One hundred and nineteen persons participated in the seminars.

The detailed data gathered during the seminars are presented in appendix D. Summaries of responses are provided in subsequent paragraphs of this section.

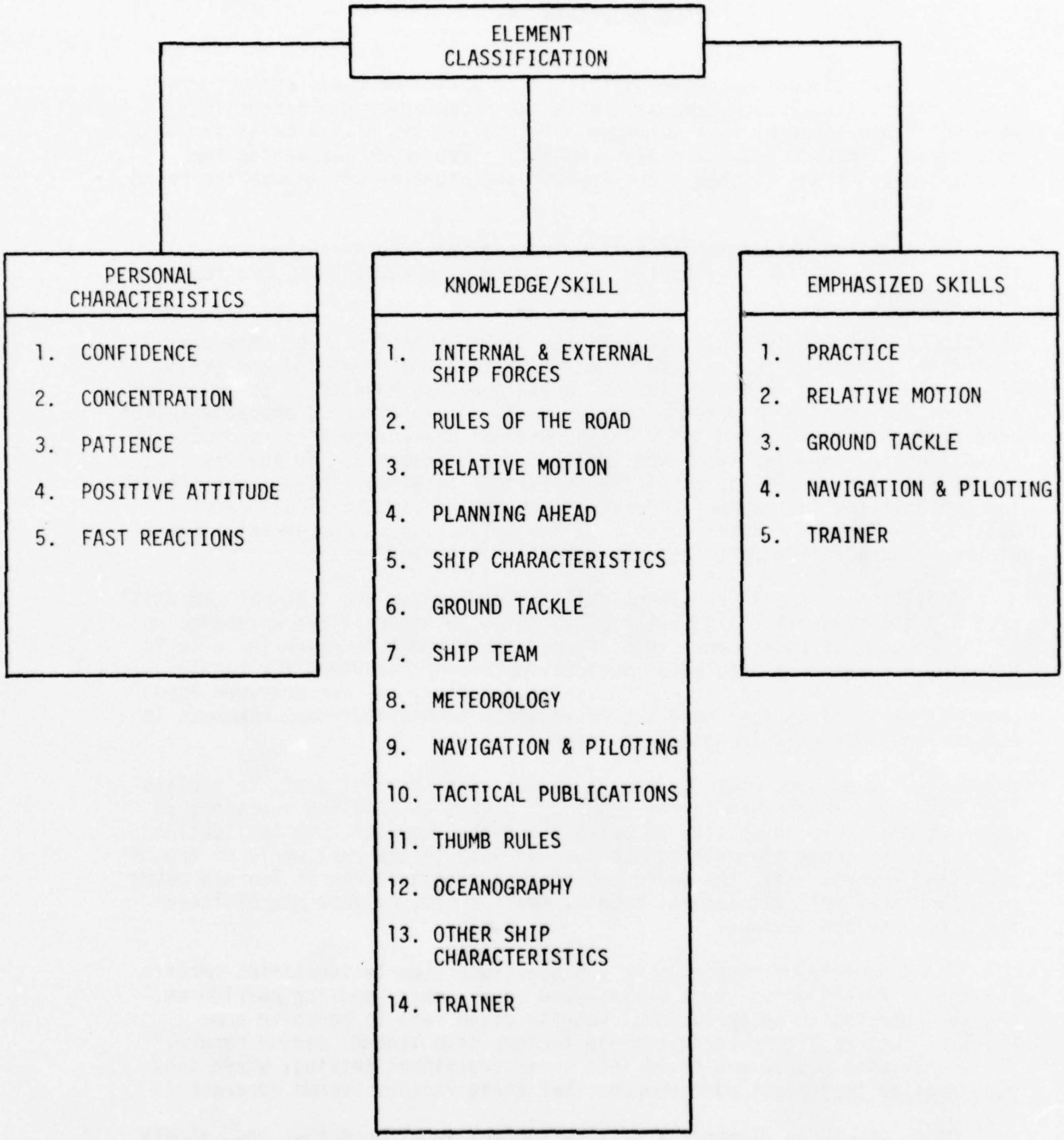
KNOWLEDGE/SKILL REQUIREMENTS AND PERSONAL CHARACTERISTICS. The responses to initial questions in the interviews identified the knowledge and skill requirements deemed necessary for all qualified ship handlers. Early in the data collection stage it became obvious that certain personal characteristics were also considered essential. These personal characteristics were usually identified in imprecise terms and included the concepts of personality characteristics or attributes of the individual (traits), information processing capabilities (detection, perceptual, cognitive, and physical), and attitudes. The respondents considered the possession of appropriate levels of these characteristics to be necessary for ship handlers.

A listing of the 14 knowledge/skill requirements, the 5 emphasized skill areas, and 5 personal characteristics is given in figure 2 and a tabulation of the percent of respondents identifying each element is given in table 1. With the exception of "trainer," definitions are not provided for knowledge/skill requirements in that they are self-evident. Definitions are provided for personal characteristics since the respondents identified these elements in complex and sometimes inconsistent terms.

Knowledge. Knowledge elements can be taught, for the most part, in a classroom setting. The acquisiton of knowledge serves an enabling function; it does not guarantee an ability to perform a task. However, the application of certain of these elements can be learned only in the real world of the operating forces, while the basic application of others can be learned using part-task trainers, simulators, models, small craft, or some mix of these training aids and devices.

The frequency of responses to the questions clearly identifies certain knowledge factors which must be included in any ship handling curriculum. However, persons in an operational setting often fail to perceive some critical factors simply because those factors have become "second nature." It is only when people are moved into an instructional setting, where they must analyze their past performance, that these factors become apparent.

Other knowledge elements are of sufficient importance that they should be graded on a "go, no-go" basis. This means a student cannot be partially correct; he is either 100 percent correct (go) or incorrect (no-go). These



NOTE: SAMPLE SIZE = 38 CIVILIAN AND NAVY ACTIVITIES

Figure 2. Classification of Ship Handling Elements

are the elements wherein there is no margin for error; e.g., a complete knowledge and understanding of the application of the rules of the road.

The amount of classroom time for each knowledge element was not estimated. However, careful consideration must be given to the following summary of the criteria as discussed above in establishing priorities of time and for inclusion in the training curriculum.

- Elements which were identified by over 50 percent of the respondent activities
- Elements which were identified by senior, certified ship handling officers now engaged in instructional duties
- Elements which require grading on a "go, no-go" basis
- Elements which can be reinforced in a controlled environment.

Examination of table 1 reveals that half of the knowledge elements meet the first criterion, while several others approach the 50 percent mark. All of the knowledge elements were identified by officers meeting the requirements of the second criterion and a majority probably meet the fourth criterion.

The foregoing discussion makes it clear that all 14 of the knowledge elements identified in this study should be included in the proposed ship handling training system.

"Trainer" is a knowledge element which is not solely a ship handling requirement. In this study, it is defined as that knowledge which enables the certified OOD(F) or commanding officer to train JO's in the knowledge/skill requirements of ship handling. That is, it is "training for training." Trainer is considered to be a requirement for the certified ship handler and therefore is included in the list of knowledge/skill requirements.

Skills. Skills, as defined in this study, are the capability to apply knowledge in the performance of a ship handling task. A knowledge may be necessary for performing a task, but it is not in itself a skill. There are skills associated with every knowledge element and with the tasks performed by each member of the ship handling team. These skills may be perceptual, cognitive, and/or physical. In addition, progressive levels of skill are implied in the three levels of ship handling competency (apprentice, intermediate, or advanced).

In many situations the ship handler may, from an analysis of the situation, exercise only skills which are perceptual or cognitive in the process of arriving at orders for the ship handling team. Therefore, it is essential that he fully appreciate the relationships between his direction,

TABLE 1. ELEMENTS REQUIRED OF A SHIP HANDLING OFFICER

ELEMENT CLASSIFICATION	SHIP HANDLING ELEMENTS (PRECEDENCE RANKING BY % SAMPLE IDENTIFICATION)																			
	INTERNAL & EXTERNAL SHIP FORCES	RULES OF THE ROAD	PRACTICE	RELATIVE MOTION	CONFIDENCE	PLANNING AHEAD	SHIP CHARACTERISTICS	GROUND TACKLE	CONCENTRATION	TEAM KNOWLEDGE	PATIENCE	POSITIVE ATTITUDE	METEOROLOGY	NAVIGATION & PILOTING	KNOWLEDGE OF TACTICAL PUBLICATIONS	THUMB RULES	OCEANOGRAPHY	OTHER SHIP CHARACTERISTICS	TRAINER	FAST REACTIONS
KNOWLEDGE/SKILLS	100 %	100 %		89 %		76 %	55 %	55 %		53 %			47 %	34 %	34 %	26 %	24 %	21 %	16 %	
EMPHASIZED SKILL			100 %	89 %				55 %						34 %					16 %	
PERSONAL CHARACTERISTICS					87 %				55 %		50 %	47 %								13 %
RANKING	100 %	100 %	100 %	89 %	87 %	76 %	55 %	55 %	55 %	53 %	50 %	47 %	47 %	34 %	34 %	26 %	24 %	21 %	16 %	13 %

Sample Size: 38 Civilian and Naval Activities

the tasks performed by the team, and the physical response of the vessel. Such an appreciation can be gained only through having personal experience in each task performed by the ship handling team. The training system proposed in a later section of the report addresses the provision of such experiences.

While each of the knowledge and skill requirements identified in figure 2 is important, respondents singled out five skill areas for particular emphasis. The development of skills associated with relative motion, ground tackle, navigation and piloting, and trainer is perceived to be deficient to a dangerous degree, particularly in the apprentice ship handler. The primary problem which led to the deficiencies appears to be the lack of opportunity for the average JO to acquire these skills during operational evolutions. Obviously, the optimum method of developing skill levels appropriate to the fully certified ship handler is to insure a systematic exposure to a complete range of ship handling evolutions in the operational environment. However, this is not possible, so apprentice levels of skill can and should be developed in the novice ship handler via a combination of classroom and training device experiences.

Respondents also identified practice as a key ingredient in the skill acquisition and maintenance cycle. Even though practice is not, in itself, either a skill or a knowledge element, for convenience it is placed with the skills and defined as the repetitious exposure to a class of situations which require similar actions with a view to the fixation or improvement of the proper responses. In addition, practice requires that the trainee integrate the various knowledge and skill elements into a composite performance with an understanding of how the elements are related. Hence, practice is intimately related to the accuracy and reliability of performance. In present ship handling training situations, concern revolves around the issues of the appropriateness of and opportunities for practice. Practice in an ashore training environment can be obtained through the correct use of simulators and/or small craft.

Personal Characteristics. The analysis of personal characteristics began with the premise that all unrestricted line officers were capable of becoming ship handlers. This premise was derived from the Navy policy which requires all unrestricted line JO's to qualify as an OOD within a 3-year time period. Reinforcement for this premise came from an analysis of the PQS for the OOD which requires certain ship handling performance demonstrations. This premise was negated by the finding that the interviewees considered several personal characteristics to be essential to a ship handler if he is to qualify within a reasonably short period of time. Although the personal characteristics are ill-defined and necessary standards for application have not been developed, they represent an initial attempt at identifying elements which should be considered for inclusion in a screening program for officers preparing for command of a combatant vessel. The definition of each of the characteristics was established by consensus and is provided in the following paragraphs.

Confidence was identified by 87 percent of the respondents. It is defined as self-assurance in the individual and thus is considered to be a character trait. A second aspect of confidence is related to the performance of ship handling tasks. That is, as the trainee progresses through the various levels of ship handling competency and is reinforced for appropriate performance he develops an assurance in his specific knowledges and skills. These two aspects of confidence interact to a significant degree and tend to reinforce each other. A third aspect of confidence requires that the ship handler be able to communicate his confidence to other members of the team either orally or by demeanor. Such behavior will have a positive effect on the team--usually in important but nonmeasurable ways. The tempo of operations today, and in the foreseeable future, precludes the opportunity for the average JO to develop appropriate levels of confidence. Consequently, some ashore training time must be devoted to this characteristic.

Concentration was the second most frequently identified personal characteristic (55 percent of respondents). It is defined as the ability to maintain exclusive attention on the primary problem to the exclusion of distractions or nonessential events. It would appear to be a complex element composed of a character trait and information processing capabilities. The perceived criticality of this element suggests that its components be delineated more precisely so that a portion of the proposed training program can deal with it.

Positive attitude was identified by 47 percent of the respondents as being an essential element of ship handling. This characteristic includes motivation, self-discipline, and decisiveness. Two circumstances were noted in which qualification and positive attitude were related. First, it was stated that without a positive attitude a JO could not qualify as an OOD. Second, if the trainee does not possess a positive attitude he may be certified because of capabilities in other areas, but the CO would insure that this "qualified" OOD was not the conning officer in potentially stressful situations. Clearly, such nonstandard practices with regard to an essential element is both a cause for concern and an impetus for further study.

The need for another personal characteristic in the qualified ship handler is related to the manner in which ships react to applied forces. Since ships tend to respond more slowly than other types of vehicles, the conning officer must determine the impact of ordered change prior to issuing new orders. This requires patience which is defined as the ability to exercise self-control and to remain calm in stressful situations. Patience most conveniently fits into the category of a character trait but may lend itself to improvement via the routes of training and practice.

The personal characteristic of fast reaction is primarily an information processing capability. It is defined as the rapid detection, recognition, and response to a stimulus, or changing situation. The ability to recognize

situations which require a response and to select an appropriate response from among a number of alternatives is dependent upon a past history of exposure to similar situations and alternatives. Neither the present operating environment nor training provide such exposure.

PROBLEMS OF A JUNIOR OFFICER IN QUALIFYING. A number of questions dealt with the requirements for qualifying as a conning officer and the difficulties encountered in meeting these requirements. Questions were restricted to Naval personnel since the Navy differed markedly from the U.S. Merchant Marine in this area. Four questions were asked; however, only three elicited quantifiable answers. Table 2 lists the questions and tabulates the responses in terms of both percentage agreement and identification of content areas. The three questions and a discussion of the answers follow.

Can Everyone Learn Ship Handling? It was believed that a simple identification of the previously identified personal characteristics was not satisfactory and it was decided to pursue this subject to some depth. To insure that the respondents were totally aware of the implications of their stated belief that not all unrestricted line officers could qualify as conning officers, yet might be of value to the Navy, an additional question was posed. The question asked whether everyone could, within the time frame established by policy, qualify as an OOD(F), and if not, why not. Thirty Naval activities of the thirty-four to which the question was posed gave quantifiable replies. Eighty-three percent gave an unequivocal no. The rationale for this belief is outlined below.

- Some people are not capable of visualizing relative motion. Although most of these persons are capable of obtaining maneuvering board solutions to relative motion problems, they are unable to visualize the spatial relationship between two moving bodies without aids. Thus, in formation maneuvering or in an in-extremis situation they are incapable of visualizing the effect of their actions with respect to other moving bodies.

- Some people do not possess an aptitude for conning.

- There are persons who cannot tolerate stress. Symptoms of this inability are reflected in a voice which cracks, confusion, or incorrect decisions under stress. These persons cannot be dependable conning officers.

- The ability to foresee and preplan for dangerous situations is a prime requisite for a conning officer. Some people do not possess this capability. Such a person may well arrive in an in-extremis situation without recognizing its potential danger.

TABLE 2. PROBLEMS OF A JUNIOR OFFICER IN QUALIFYING

QUESTION	RESPONSE: Quantitative (Percent) Yes	RESPONSE: Quantitative (Percent) No	RESPONSE: Qualitative (Responses Rank Ordered)
1. (A) Can everyone learn ship handling?	17	83	
(B) What characteristics must a ship handler have?			1. Visual relative motion 2. Aptitude 3. Calm under stress 4. Plan ahead 5. Concentration 6. Alert
2. Pragmatically, is conning a secondary duty?	89	11	
3. (A) Are PQS conning requirements met by all SWO in qualifying?	16	84	
(B) Why are PQS requirements not met?			1. Lack of underway time 2. Too many JO's 3. Personnel turn-over 4. Senior command pressures
4. What is the greatest JO training deficiency?	Responses not conducive to analysis		

Sample Size: 34 Naval Activities

All conning officers must be capable of total concentration on the primary problem. They must be able to exclude distractions and ignore secondary or nonessential happenings. Concentration, preceded by an assessment of the situation and isolation of the major problem, is a personal characteristic which can be developed if the foundation is present. Some people do not possess the ability to concentrate.

Regardless of the environment, time, or circumstances, all conning officers must be totally alert to their surroundings. Instances were cited of officers who could not remain alert for a full watch. Senior officers stated that they feared these conning officers since they frequently could not recognize a hazardous situation in time to call for help, or take proper avoiding action on their own.

Navy-wide implications of the conclusion that not all unrestricted line officers as presently defined can be certified as qualified conning officers are beyond the scope of this study. However, in terms of CNET's responsibility certain issues should be given special consideration.

- Given existing policy (i.e., all unrestricted line officers can qualify as ship handlers), and given a ship handling training system, is it feasible to put all officers through the ship handling training system in light of decreasing resources and increasing training commitments?

- Given that not all unrestricted line officers can qualify as OOD's, can a series of aptitude/trait measures be developed to identify persons with limited ship handling potential? If so is there a place for these people in the Navy of today and tommorrow?

<u>Pragmatically, Is Conning A Secondary Duty?</u> The importance of the responses to this question lies in the identification of the emphasis placed on ship handling and conning by both the watch officer and his command. Although the consensus was that the conning duty is the primary task when an officer is on watch on the bridge, 89 percent of the respondents (24 of 27 activities) believed that this task has been relegated to secondary importance by senior commands. Reasons cited were ever increasing administrative workload caused by many new programs, increased emphasis on other departments caused by the rising number of casualties, and the decreased availability of time for ship handling training. After the requisite knowledge and skills have been acquired in a ship handling training system, it is imperative that the capabilities developed be maintained. Maintenance of the skills is highly unlikely unless the conning of an underway ship is returned to a primary function, and senior command policy and actions reinforce the importance of the conning officer.

Are PQS Conning Requirements Met By All Surface Warfare Officers (SWO's) In Qualifying? The ship's commanding officer is responsible for certifying the JO as a qualified conning officer. In so doing, he uses the PQS as a standard. Two questions are of importance with regard to the PQS. First, are the criteria for PQS standardized between and within commands? Second, is the PQS being properly performed and utilized?

There was universal agreement among operational force personnel that the criteria for completion of the PQS were not standard. This means that an officer qualifying in the conning arts under one commanding officer may not meet the minimum requirements of another commanding officer. It was agreed that PQS represents a big step forward; however, it falls short of its potential.

Eighty-four percent of the respondents stated that the PQS conning requirements are not met by all SWO's in qualifying as OOD's. The four most frequently stated reasons for this discrepancy were:

1. There is not enough underway time.

2. There are too many JO's for the evolutions available.

3. Personnel turnover.

4. Commanding officers are under pressure by senior commands to perform with a minimum of risk. Recently installed underwater equipment adds to this pressure. These factors cause a tendency to hold to a minimum the number of officers who perform actual conning duties in ship handling situations.

Thus, it is found that the PQS requirements are unrealistic when compared to the conditions as they exist in the Fleets.

ADVANCED TRAINING CONSIDERATIONS. The final questions in the interviews dealt with the need for advanced training, its timing, and its scope. Advanced training is that which is given to senior officers after they have been certified as qualified OOD's. Five questions were discussed during this portion of the seminars. The questions pertained to certification/recertification, PQS criteria, refresher training, transition training, and the nonsurface officer's qualifications to train JO's in the conning arts. Each area is discussed in a subsequent section. A summary of the responses to each question is given in table 3. These questions were directed toward Naval activities only, and not all activities gave quantifiable responses. There was a tendency on the part of many groups to talk around the question rather than address it directly.

TABLE 3. SHIP HANDLING ADVANCED TRAINING CONSIDERATIONS

QUESTION	RESPONSE: Quantitative (Percent) Yes	No	Qualitative (By Precedence)
1. (A) Should ship handlers be certified?	71	29	
(B) Should ship handlers be periodically recertified?	83	17	
(C) When? (Certified and recertified)			1. Change of ship 2. Shore/sea rotation 3. PCO/PXO
(D) By whom? (Certified and recertified)			1. JO's by CO 2. PCO/PXO board 3. Squadron Commander
2. Are criteria for PQS qualification standard?	0	100	
3. Do senior officers require refresher training?	74	26	
4. Do senior officers require transition training?	96	4	
5. Are senior subsurface/air officers trained to train surface warfare officers?	43	57	

Sample Size: 34 Naval Activities

Certification/Recertification. The U.S. Coast Guard certifies Merchant Marine officers in accordance with the Code of Federal Regulations (1975) and Naval aviators are qualified (certified) then requalified (recertified) annually as directed by Naval Air Training and Operating Procedures Standardization (NATOPS) Program (1973). Thus, the concept of certification for SWO's is neither new nor without parallel.

The certification discussion commenced with the statement that, when a CO signed a letter of qualification for an officer as OOD, he was effectively certifying that officer as a qualified ship handler. The certification and periodic recertification of senior officers who are not commanding officers or executive officers was generally considered to be accomplished today under the existing system. When officers first report aboard a new ship, they are requalified (recertified) as OOD by the CO. This procedure is generally applicable to newly reporting executive officers although it is not universal. PCO's are certified under the recently instituted Command Selection Board procedures.

Recertification for PCO's who are reporting to a ship from extended duty away from seagoing units presents another problem. Only 18 activities responded to this question and of these 83 percent believed recertification would be a good procedure. There was no agreement as to who should conduct the recertification, but it was generally thought that CNET, in a revised PCO/PXO Course, should prepare the officer.

It was of particular interest that the Naval aviators and senior ship handlers in the rank of lieutenant commander and lieutenant of the 11XX designator group generally supported the concept of recertification, while the senior surface officers of the rank of lieutenant commander with over 18 years of service, and more senior officers generally avoided the question or opposed the idea. Thus, it would appear that tradition played a strong part in these discussions.

PQS Criteria. No standard criteria exist for qualifying SWO's in the conning area of the PQS. This finding is supported by Hart (1976) when he stated:

> The SWO qualification is not now a standard for a number of significant reasons:
>
> - Not all officers have attended SWO School.
> - Surface Warfare Officers serve on board different types of ships, ranging from minesweepers to aircraft carriers.
> - PQS examination and demonstration is left to the interpretation of each command.

- The OOD and CICWO qualifications are different for each class of ship. They range anywhere from independent operations to task force steaming.
- There is no method of standardized testing with centralized administration.

Commanding officers expressed a need for standardization of certification along with maintaining adequate records of prior conning experience. Their greatest concern lay in that newly reporting, previously qualified SWO's had no verified record of prior experience upon which commanding and executive officers could judge their capabilities. One example of such record keeping was uncovered. During a period from about 1969 to 1972 the Commander, Cruiser Destroyer Force, U.S. Pacific Fleet (COMCRUDESPAC), promulgated an Officer of the Deck Underway Watch Qualification Log (11ND-COMCRUDESPAC-GEN-3120/1 (6-70) 0190-207-1500). This pocket booklet was to be maintained current by the individual officer, and periodically verified by his CO or the Senior Watch Officer. Its use was discontinued with the elimination of that Command and the absorption of COMCRUDESPAC's functions by the Commander, Surface Forces, U.S. Pacific Fleet.

The OOD Underway Watch Qualification Log included forms for the entry of qualifications, hours spent as OOD/JOOD, special evolutions as conning officer, and mishaps. It filled a void which existed in the Pacific Fleet. Since its discontinuance, the void, which always existed in the Atlantic Fleet, has reappeared in the Pacific. A more detailed discussion of this log is contained in appendix E.

Refresher Training. Refresher training is defined as training given senior conning officers prior to reporting to a ship after an extended period in a nonseagoing billet. It includes the knowledge and skill elements identified earlier in this section of this report and limited practice on devices and small craft. Seventy-four percent of the respondents believed that refresher training is necessary and that it should be a part of the CNET mission.

Transition Training. Transition training is a short period devoted, primarily, to studying the unique characteristics of the ship an officer is being ordered to for duty. This training should be given to officers in transit from one class of ship to another which has markedly different handling characteristics. Over 95 percent of the respondents stated that this training would be of immense value and should be handled at the Fleet Training Centers (FTC's).

Nonsurface Officers Qualifications to Train Junior Officers in the Conning Arts. It became apparent that senior officers who had not been exposed to conning situations for extended periods had a more difficult time training JO's than those who had had continuous experiences aboard

ships. In particular, this problem was true of Naval aviators and, given the operations of the present nuclear submarine service, will apply to the senior submariners. Therefore, the interviewees were asked what difficulties these people had in training JO's in the conning area. The intent of this question was to identify whether senior officers need training to train.

In ships where the CO did not have extensive surface ship background, but the executive officer did, the consensus was no. The executive officer performed the training functions. However, concern was expressed for a ship's training program when neither the CO nor the executive officer had had extensive and reasonably continuous surface ship exposure to ship handling situations. Fifty-seven percent of the respondents did feel they needed assistance in training JO's. Most activities where both the CO and the executive officer had had extensive surface experience avoided this question.

SECTION III

INCIDENT CAUSE, ENVIRONMENT, AND ANALYSIS

The total number of incidents which occur at sea and in harbor has not decreased markedly despite the increasing availability of numerous electronic aids to the conning officer. Even though there has been a reduction in the numbers of ships and operating time, the U.S. Navy reported 78, 82, and 70 collisions respectively to the Naval Safety Center for the years 1973, 1974, and 1975. During the same 3 years, 17, 12, and 9 groundings were reported. Safety Center personnel have stated that despite instructions not all accidents or near misses are reported to them; many are handled locally since the damage was not of major proportions, or the CO of the vessel did not see the necessity for reporting near misses.

This section is devoted to a study of actual incidents and the isolation of identifiable contributing factors. It is equally important to determine the environment within which each accident occurred since the environment, in many instances, may be linked to the cause.

SUMMARY

This section presents the findings of analyses of 196 Navy and Merchant Marine accident reports in terms of the environment and human factors. Figure 3 depicts a frequency breakdown of the accidents by service; i.e., Navy or Merchant Marine, and type.

An analysis of the collisions and groundings of Naval vessels was made. Since the proposed training system developed later in this report is for Naval rather than Merchant Marine officers, no analysis of Merchant Marine accidents was made. However, all data are presented.

The analysis isolates the dominant environmental and human factors for each type of accident. In the great majority of accidents, weather, wind, and current played no part. A small number of human factors had a bearing on approximately 80 percent of the incidents. Either a lack of basic knowledge, or the inability to apply basic knowledge is the major cause of incidents.

Two special cases are investigated; they are accidents other than collisions and groundings, and wake damage. In the former instance the number of accidents occurring as compared to the total number is insignificant. No analysis was possible. The latter case, wake damage, is the result of a lack of command appreciation of the wake effect.

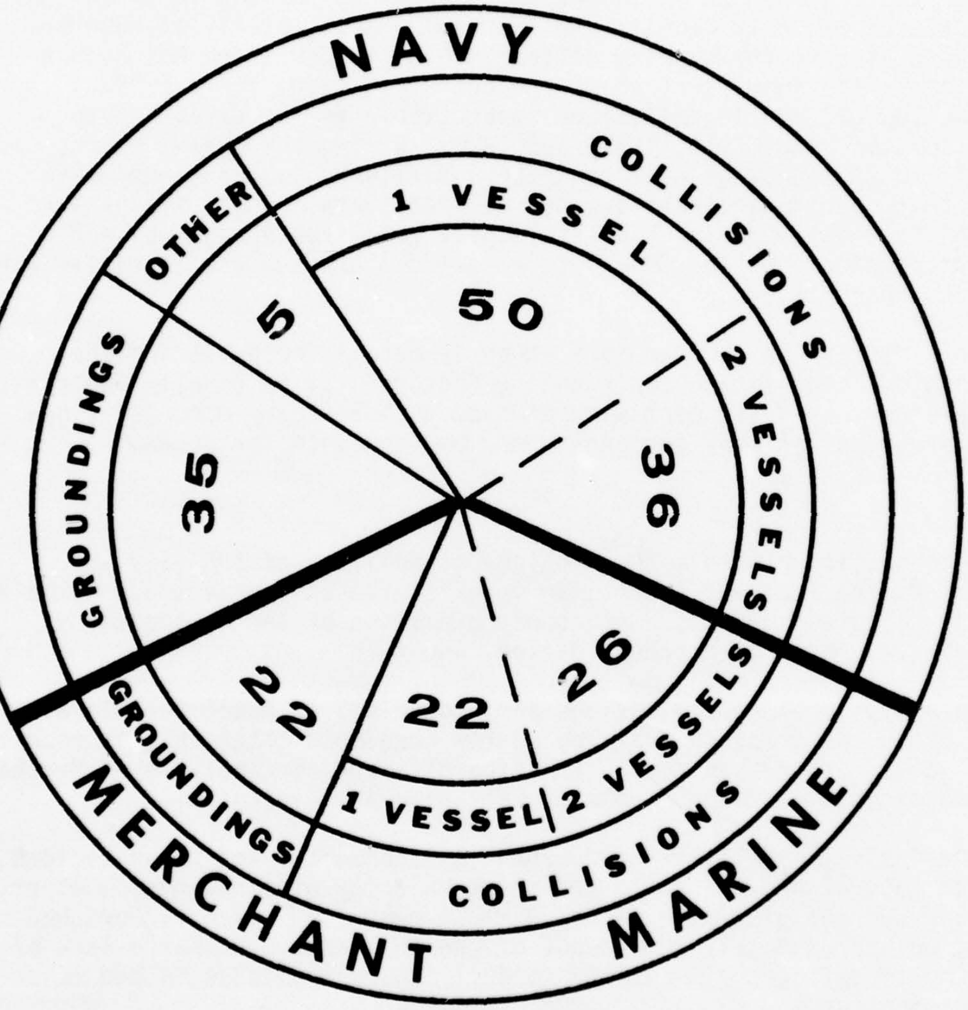


Figure 3. Accident Frequency By Type Of Accident By Service

DISCUSSION

The Navy JO ship handling training problem is similar to that of the Merchant Marine apprentice deck officer. The difference is, primarily, in mission emphasis and in the relationship to and number of supporting functions available to assist the conning officer. In addition, the tasks performed and the situations faced by the conning officer in both services are parallel. There are minor differences primarily in the amount of steaming done in a congested setting, and certain specialized missions performed by Navy ships. It was decided to examine ship handling incidents which involved Merchant Marine units independently of, as well as in conjunction with, Navy units.

The following constraints were placed on accidents to be examined:

- Only accidents in which the conning officer was a Naval officer or his equivalent in the Merchant Marine were included.

- A vessel at anchor or moored was considered to be a stationary object. Therefore, a collision between a vessel underway and one anchored or moored was treated as if the stationary vessel were an immovable object equating to a pier, buoy, etc.

- Collisions between large and small vessels were based on a size ratio of 10 to 1. However, among Naval vessels two capital ships were always both considered to be large. For example, a destroyer type of about 4000 tons and a carrier type of over 40,000 tons were both considered large vessels.

- Data for merchant vessel accidents was not as complete as for Naval vessel accidents. Even reported Naval accidents did not always contain full information, primarily as pertains to the environment. In merchant vessel accidents if the cause of the accident and its location could be determined, it was included. Basic required data for Naval vessel accidents were limited to the following:

  1. Primary cause of the incident
  2. Location
  3. Conning Officer
  4. Type of incident
  5. Any nine of the desired fourteen usable data elements enumerated in appendices G and H were available.

- No extrapolations from known data were made to fulfill the basic data requirements. Only reports which contained the basic required information were used.

- Accidents due solely to poor seamanship or equipment malfunctions were not included in the analysis unless an element of ship handling was also involved in the cause.

DATA DESCRIPTION

DATA SOURCES. Data concerning incidents which involved ships underway were gathered from three sources. These are:

1. The Office of the Judge Advocate General of the Navy (JAG): Admiralty and Investigative Sections: These sections of the JAG permitted access to their files of completed cases. The JAG files were the only place accidents involving Navy and merchant vessels appeared in an identifiable, complete report. Twenty-two Naval and seventy-five Merchant Marine/Navy accidents were extracted from these files. In addition a special case of improper ship handling, wake damage due to excessive speed in confined waters, appears only in the JAG files. Accidents extracted from the JAG files were classified Navy or Merchant Marine depending upon which vessel had been adjudged to have the greatest degree of fault.

2. The Naval Safety Center: All incidents which involve Navy or Navy operated ships are, in theory, reported to the Naval Safety Center. Each report is classified by incident type and stored in a machine retrievable file. The Surface Ship Safety Programs Division was requested to furnish the TAEG a summary of all incidents reported for the period 1973 to 1976 (through 1 June). This summary of 383 incidents was reviewed and a subsequent request submitted for the complete report of 141 accidents. Of these, 116 met the basic criteria and are used in this report.

3. Chamber of Shipping of the United Kingdom: No complete records of exclusively Merchant Marine accidents with an analysis of cause were located in the United States. U.S. Coast Guard reports are sketchy and, generally, incomplete. However, the Chamber of Shipping of the United Kingdom (1972a) has issued a publication containing 50 marine casualties which have been analyzed in sufficient detail to meet the basic criteria established for this study.

DATA BREAKDOWN. Each incident was examined in terms of the environmental and human contributory factors. There is seldom one cause of an accident. " 'Accident' is the overall description of a series of events, decisions, and situations which culminate in injury or damage. Each and every accident has a different 'causal chain' or 'web,' the only common element being the undesirable injury or damage" (Surry, 1971). In both environmental and human factor areas it became apparent that multiple variables within each factor were applicable in many accidents. Therefore a single accident may be tabulated several times in different categories of variables, resulting in a higher count of contributing variables within some factors than the total number of accidents. In a discussion of the watch, Navy vessels have the same six watches as the Merchant Marine plus the special sea and anchor or maneuvering detail. This special detail is either not applicable or not reported in Merchant Marine casualty reports.

Data were also tabulated according to the type of accident, and whether the primary fault lay with the Naval vessel or the Merchant Marine ship. Three major accident categories were identified--collisions, groundings, and any other accident which could be blamed on faulty ship handling.

Collisions were separated into those which involved two underway vessels and those involving one underway vessel and a stationary object. There were a total of 86 Navy collisions, 36 between 2 underway vessels and 50 involving 1 underway vessel. There were also 48 Merchant Marine collisions 26 between 2 underway vessels and 22 involving 1 underway vessel.

Groundings included all incidents during which an underway or an anchored vessel struck the bottom or a submerged object. Although not all groundings resulted in damage, nevertheless, they did require the expenditure of resources to, at the very least, inspect the underwater hull; therefore, all reported groundings were included. There were 35 Naval vessels and 22 Merchant Marine vessels grounded.

Other included all accidents reported, excluding collisions and groundings. Only Naval vessels were involved in this category, and only five were reported.

Detailed data on all accidents are presented in appendix F; a summary by factor follows.

FACTOR DEVELOPMENT

ENVIRONMENTAL FACTORS. It was determined that eight environmental factors could impact on a ship to the degree that they became causes of accidents. A complete list of the factors considered is presented in appendix G. Because of their relevance to ship handling, they should be isolated and analyzed for possible inclusion in a training system. Each

factor is discussed subsequently in this section. Table 4 summarizes the findings of the ship handling accident analysis from an environmental standpoint. The data in this table can be translated into the average profile of the environment which existed when the accidents occurred.

Time is divided into daylight, dusk, and dark. Since viewing techniques and visual perception vary with the available light, and because recognition can be affected by target angle, background, glare, etc., it was deemed critical to establish the general lighting conditions at the time of the accident. Overall, 60.7 percent of all accidents occurred during daylight hours. This could imply a more relaxed attitude on the part of the conning officer, or it could indicate an increased willingness to assume risk.

Watch identifies two elements, the particular time of day the accident occurred and, for Naval vessels, whether the special sea or maneuvering detail had been set. Nearly 50 percent of all accidents occurred between 0800 and 1600 which is, obviously, the normal working day.

In terms of the Merchant Marine, almost 40 percent of the collisions between two underway vessels, and 50 percent of the groundings occurred during the mid-watch (0000-0400). This could be indicative of less qualified conning officers on watch, or a lack of proper attention to detail.

Naval vessels, on the other hand, had 54 percent of their accidents when the "first team"; i.e., the special sea or maneuvering detail, was set. This, in conjunction with the fact that most accidents occurred during daylight hours, led to the finding that the Navy's ship handlers are lacking in one or more of the basic elements identified in section II.

Visibility defines the distance a conning officer can see other objects. In approximately 71 percent of the accidents, visibility was unlimited, and in over 80 percent of the surveyed accidents visibility was greater than 1 mile. This has caused the study team to question the manner in which lookouts are used and trained. An even more critical consideration is the conning officer himself. When the infrequent occurrence of accidents during fog and precipitation is considered, one wonders where the conning officer was stationed.

Fog is one of the two factors which can reduce visibility during daylight hours. It is noteworthy that in approximately 81 percent of the accidents there was not even a slight haze.

Precipitation is the other factor which reduces visibility. Only 9 percent of the accidents occurred during periods of rain or snow. This

TABLE 4. SHIP HANDLING ACCIDENT ANALYSIS SUMMARY
ENVIRONMENTAL FACTORS

VARIABLE	COLLISIONS				GROUNDINGS		OTHER	TOTAL ACCIDENTS
	SHIPS		OTHER					
	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	
I TIME	%	%	%	%	%	%	%	%
DAYLIGHT	58.3	26.9	84.0	72.7	71.4	18.2	80.0	60.7
DUSK	8.3	19.2	12.0	9.1	11.4	9.1	0	11.2
NIGHT	33.3	53.8	4.0	18.2	17.1	72.7	20.0	28.1
II WATCH								
MIDWATCH (00-04)	13.9	38.5	2.0	4.5	0	50.0	33.3	14.9
MORNING (04-08)	8.3	23.1	12.0	13.6	20.0	18.2	0	14.9
FORENOON (08-12)	27.8	7.7	38.0	22.7	25.7	4.5	66.7	24.7
AFTERNOON (12-16)	19.4	15.4	24.0	45.5	31.4	4.5	0	23.2
EVENING (16-20)	13.9	3.8	20.0	4.5	11.4	9.1	0	11.9
FIRST (20-24)	16.7	11.5	4.0	9.1	11.4	13.6	0	10.3
SEA DETAIL	22.2	-	78.0	-	54.3	-	33.3	34.0
III VISIBILITY								
CLEAR, UNLIMITED	88.6	23.1	92.0	72.7	60.0	59.1	100	70.8
SLIGHTLY REDUCED	5.7	7.7	2.0	9.1	11.4	27.3	0	8.7
REDUCED (500-2000)	5.7	23.1	6.0	4.5	11.4	9.1	0	9.2
POOR (UNDER 500)	0	46.2	0	13.6	17.1	4.5	0	11.3
IV FOG								
NONE	94.3	34.6	94.0	85.7	74.3	86.4	100	80.9
SLIGHT HAZE	2.9	0	2.0	0	8.6	9.1	0	3.6
FOG PATCHES	2.9	11.5	2.0	4.8	5.7	0	0	4.1
DENSE FOG	0	53.8	2.0	9.5	11.4	4.5	0	11.3

TABLE 4. SHIP HANDLING ACCIDENT ANALYSIS SUMMARY
ENVIRONMENTAL FACTORS (Continued)

VARIABLE	COLLISIONS				GROUNDINGS		OTHER	TOTAL ACCIDENTS
	SHIPS		OTHER					
	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	
V PRECIPITATION	%	%	%	%	%	%	%	%
NONE	100	84.6	96.0	90.9	88.6	68.2	100	90.3
DRIZZLE	0	3.8	2.0	4.5	5.7	0	0	2.6
HEAVY RAIN	0	3.8	0	0	0	4.5	0	1.0
RAIN SQUALLS	0	3.8	2.0	4.5	5.7	22.7	0	5.1
SNOW	0	3.8	0	0	0	4.5	0	1.0
VI WIND FORCE								
CALM	28.6	61.5	26.0	36.4	44.1	31.8	80.0	37.6
1-3 KNOTS	0	0	4.0	4.5	0	4.5	0	2.1
4-6 KNOTS	8.6	11.5	2.0	4.5	11.8	13.6	0	7.7
7-10 KNOTS	31.4	19.2	24.0	18.2	5.9	4.5	0	18.0
11-16 KNOTS	17.1	3.8	24.0	9.1	11.8	0	0	12.9
17-21 KNOTS	11.4	0	6.0	9.1	8.8	4.5	0	6.7
22-27 KNOTS	2.9	0	8.0	0	8.8	13.6	0	5.7
28-33 KNOTS	0	0	2.0	4.5	5.9	13.6	0	3.6
34-40 KNOTS	0	3.8	4.0	9.1	2.9	9.1	20.0	4.6
OVER 40 KNOTS	0	0	0	4.5	0	4.5	0	1.0
VII CURRENT FORCE								
LESS THAN .5 KNOTS	97.2	73.1	72.0	86.4	65.7	72.7	100	78.1
.5-2 KNOTS	0	23.1	18.0	13.6	25.7	13.6	0	15.3
2.5-4 KNOTS	2.8	3.8	6.0	0	8.6	13.6	0	5.6
4.5 - 6 KNOTS	0	0	0	0	0	0	0	0
OVER 6 KNOTS	0	0	4.0	0	0	0	0	1.0

TABLE 4. SHIP HANDLING ACCIDENT ANALYSIS SUMMARY
ENVIRONMENTAL FACTORS (Continued)

VARIABLE	COLLISIONS SHIPS		COLLISIONS OTHER		GROUNDINGS		OTHER	TOTAL ACCIDENTS
	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	
VIII LOCATION	%	%	%	%	%	%	%	%
OPEN SEA	45.5	40.7	2.0	4.3	14.3	3.8	20.0	19.0
RESTRICTED PASSAGE	2.3	14.8	4.0	8.7	20.0	26.9	0	11.0
APPROACH TO PORT	4.5	11.1	2.0	8.7	0	34.6	0	8.1
IN SHIP CHANNEL	9.1	22.2	8.0	4.3	37.1	19.2	20.0	16.2
IN HARBOR	15.9	7.4	34.0	34.8	14.3	3.8	20.0	19.5
MANEUVER IN ANCHORAGE	2.3	0	2.0	8.7	0	7.7	0	2.9
ANCHORED	0	3.7	0	8.7	5.7	3.8	20.0	3.3
UNDERWAY REPLENISHMENT	20.5	0	0	0	0	0	0	4.3
APPROACH TO STATIONARY OBJECT	0	0	48.0	21.7	8.6	0	20.0	15.7

indicates that precipitation is not a major environmental factor.

Wind Force is tabulated on the Beaufort Scale. Originally it was thought that the relative wind direction would have an important impact on accidents. However, it became obvious that the strength of the wind rather than its direction was the important factor. This is probably due to the changing course of the ship over the time period immediately preceding the accident, with the resultant variable relative wind direction. It is realized that ship design characteristics; i.e., sail area and number of propellers, play a critical part in ship handling. Nevertheless, conning officers' statements indicate that they have problems compensating for the force of the wind rather than its direction. Winds were less than 17 knots in approximately 78 percent of the accidents. This means high winds of unusual force are probably not a causative factor in most accidents.

Current was found to be similar to wind in that the direction relative to the ship played a small part. The very presence of current, regardless of direction, was important. Even so, relatively few accidents (21.9 percent) occurred with a strong (over .5 knot) current.

Location defines the locale of the accident. There are more location variables than accidents since, in some instances, more than one variable had a bearing on the accident. Most collisions (over 40 percent) between two underway vessels occurred in the open sea with, in terms of the Navy, the second most frequent location being during underway replenishment. Other collisions (approximately 34 percent) occur most frequently in port, usually on approaches to a pier. Groundings, on the other hand, usually occur either before entering an actual harbor or while leaving.

HUMAN FACTORS. Within the context of this study, human factors are errors of the conning officer in judgment, leadership, or the use of the physical system. The conning of a ship is the manipulation of a system composed of the vessel itself, the operating team, the control or interface, and procedures. This system is required to function in a variable environment with the control performing the required adjustments to the system to insure safe and correct movement. The control is the conning officer and, as such, is the environment-team interface. One desired set of information, the conning officer's experience, was not available. Attempts to acquire this information led to frustration. A complete list of those factors considered in the analysis are presented in appendix H. Each factor is discussed in subsequent paragraphs, while table 5 summarizes the human factors involved in ship handling accidents. The data in this table can be translated into a profile of human factors contributing to these accidents.

TABLE 5. SHIP HANDLING ACCIDENT ANALYSIS SUMMARY
HUMAN FACTORS

VARIABLE	COLLISIONS				GROUNDINGS		OTHER	TOTAL ACCIDENTS
	SHIPS		OTHER					
	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	
I CONNING OFFICER	%	%	%	%	%	%	%	%
CO (MASTER)	30.6	7.7	26.0	27.3	31.4	9.1	0	23.0
XO (1st OR 2nd OFFICER)	0	19.2	0	4.5	0	31.8	0	6.6
OTHER QUALIFIED W.O.'S	69.4	73.1	72.0	68.2	68.6	54.5	100	69.4
UNQUALIFIED	0	0	2.0	0	0	4.5	0	1.0
II CO ON BRIDGE								
LESS THAN 5 MINUTES	0	7.7	0	0	0	0	0	1.0
6 - 15 MINUTES	0	7.7	0	0	2.9	9.1	0	2.6
MORE THAN 15 MINUTES	80.6	73.1	92.0	81.8	79.4	72.7	75.0	81.4
NOT ON BRIDGE	19.4	11.5	8.0	18.2	17.6	18.2	25.0	14.9
III PRIMARY CAUSES								
RULES OF ROAD	18.2	54.1	2.5	10.0	0	5.7	0	12.1
MAINTAIN OTHER SHIP PLOT	0	10.8	0	0	0	0	0	1.3
TAKE ADEQUATE FIXES	1.8	0	1.2	3.3	17.5	17.1	0	6.5
INADEQUATE USE NAV. AIDS	0	2.7	3.8	10.0	23.8	20.0	14.3	9.8
INTERNAL SHIP FORCES	3.6	0	12.5	3.3	3.2	0	0	4.9
EXTERNAL SHIP FORCES	14.5	0	27.5	23.3	7.9	14.3	14.3	15.6
GROUND TACKLE	1.8	0	10.0	13.3	3.2	2.9	14.3	5.5
GRASP SITUATION	9.1	10.8	11.2	3.3	6.3	17.1	14.3	9.8
MAINTAIN LOOKOUT	1.8	10.8	1.2	3.3	0	0	0	2.3
UP-TO-DATE CHARTS	0	0	0	3.3	0	2.9	0	.7
COMMUNICATION BREAK	5.5	0	10.0	3.3	4.8	2.9	14.3	5.5
COMMAND LEADERSHIP	1.8	0	2.5	3.3	12.7	2.9	0	4.2
WATCH INATTENTION	12.7	0	0	0	0	0	14.3	2.6
PILOT OVERRELIANCE	3.6	5.4	8.8	10.0	6.3	2.9	0	6.2
AIDS OVERRELIANCE	0	5.4	0	6.7	3.2	5.7	0	2.6
MECHANICAL FAILURE	10.9	0	3.8	3.3	1.6	5.7	14.3	4.6
DOCTRINE FAILURE	14.5	0	5.0	0	9.5	0	0	5.9

TABLE 5. SHIP HANDLING ACCIDENT ANALYSIS SUMMARY
HUMAN FACTORS (Continued)

VARIABLE	COLLISIONS				GROUNDINGS		OTHER	TOTAL ACCIDENTS
	SHIPS		OTHER					
	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	MERCHANT	NAVY	
IV SECONDARY CAUSES	%	%	%	%	%	%	%	%
RULES OF ROAD	0	8.0	2.9	5.9	0	0	0	2.5
MAINTAIN OTHER SHIP PLOT	0	28.0	0	0	0	0	0	4.3
TAKE ADEQUATE FIXES	4.3	0	0	5.9	3.0	13.8	0	4.3
INADEQUATE USE NAV. AIDS	8.7	4.0	0	11.8	15.2	17.2	0	9.2
INTERNAL SHIP FORCES	8.7	0	0	5.9	3.0	0	0	2.5
EXTERNAL SHIP FORCES	8.7	4.0	8.8	0	12.1	6.9	0	7.4
GROUND TACKLE	8.7	0	14.7	17.6	3.0	3.4	50.0	8.0
GRASP SITUATION	13.0	8.0	17.6	5.9	21.2	3.4	0	12.3
MAINTAIN LOOKOUT	0	0	0	5.9	0	0	0	.6
UP-TO-DATE CHARTS	0	0	0	0	0	0	0	0
COMMUNICATION BREAK	13.0	12.0	11.8	23.5	18.2	17.2	0	15.3
COMMAND LEADERSHIP	17.4	0	14.7	0	9.1	17.2	0	10.4
WATCH INATTENTION	0	0	0	0	0	0	0	0
PILOT OVERRELIANCE	0	0	17.6	11.8	6.1	0	50.0	6.7
AIDS OVERRELIANCE	0	20.0	0	0	3.0	10.3	0	5.5
MECHANICAL FAILURE	4.3	12.0	8.8	5.9	0	10.3	0	6.7
DOCTRINE FAILURE	13.0	4.0	2.9	0	6.1	0	0	4.3
V PILOT ON BOARD								
YES	5.6	30.8	38.0	27.3	28.6	18.2	40.0	26.0
NO	94.4	69.2	62.0	72.7	71.4	81.8	60.0	74.0
VI LARGE/SMALL VESSEL								
YES	36.1	42.3	NA	NA	NA	NA	NA	38.7
NO	63.9	57.7	NA	NA	NA	NA	NA	61.3

Conning Officer refers to the status of the person having the con at the time of the accident. One slight modification to the interpretation of the data was made. If a conning officer was relieved by his superior immediately prior to the accident, or when the ship had reached an in-extremis situation, then the original conning officer was considered to have had the con at the time of the accident. This decision was based on the logic that the initial decisions which placed the vessel in a situation which led to an accident were incidents of poor ship handling, and the new conning officer's; i.e., the relieving superior's, task was to counter the effects of poor judgment. The relieving officer may have contributed to the poor ship handling but he was not directly responsible for the situation itself.

When a pilot was embarked and in control of the maneuvering, he was considered to have had the con whether his orders were relayed to the ship handling team or passed directly. A pilot was considered to be a qualified watch officer. Pilots are supposed to function as consultants to conning officers rather than act as conning officers. However, discussions with operating personnel, both Navy and Merchant Marine, and the study of accident reports, led to the finding that the consultant role was, in practice, a misnomer. In over 25 percent of the 196 accidents investigated, a pilot was embarked. This statistic is even more impressive when the collisions involving two underway vessels are eliminated from the analysis. In single underway vessel collisions and groundings there was a pilot involved 31 percent of the time. These statistics suggest that conning officers do not fully understand the prescribed role of a pilot and their own responsibilities with respect to the safety of the ship.

Commanding Officer on the Bridge is used to identify the percentage of accidents wherein the conning officer recognized a dangerous situation and requested assistance of the CO. Discussions with senior, well-qualified, ship handlers established the fact that if the CO had been on the bridge 15 minutes or more prior to the accident, he should have had ample time to take proper avoiding action to avert the accident. Furthermore, the consensus of those officers was that if the CO had been on the bridge between 5 and 15 minutes prior to the accident, he probably had time to avoid an accident. When one considers that the CO had the con in 23 percent of all accidents, and had been on the bridge for over 15 minutes in over 81 percent of these accidents, it becomes apparent that conning officers do recognize a dangerous situation most of the time, and do request help.

Primary Causes is used to identify the direct and immediate reasons each accident occurred. As has been stated, accidents are most often the result of a causal chain of events and decisions rather than a single mistake. The Chamber of Shipping of the United Kingdom (1972b) had this to say about marine casualties:

Casualty analysis number 1 stresses two principal factors as being the main cause of casualties and subsequent evidence would seem to confirm that view in full. These factors are:

(a) Failure to keep a good look out.

(b) Weaknesses in bridge organization.

Failure to keep a good look out

The maintenance of a continuous and alert look out by the officer of the watch is the single and most important consideration in the avoidance of casualties. The keeping of an efficient look out requires to be interpreted in its fullest sense which includes the following items:

(a) A constant alert all round visual look out to enable a full grasp of the current situation, including ships and landmarks in the vicinity, to be maintained;

(b) the need to observe changes in the weather, including - especially - the visibility;

(c) the need to observe closely the movement and compass bearing of approaching vessels;

(d) the need to identify ship and shore lights with precision;

(e) the need to observe the radar and echo sounder displays;

(f) the need to ensure that the course is steered accurately and that - where relevant - helm orders are correctly executed.

Weaknesses in bridge organization

While the vigilance and competence of the officer of the watch inevitably provides the most direct means - at the tactical level - of avoiding casualties, this will be enhanced if his duties are carried out within the general

regime of an efficient bridge organization clearly laid down by the master and supplemented as necessary to meet current conditions in the master's night order book.

Weaknesses in bridge organization have undoubtedly been a contributory cause in a number of casualties.

Clear written instructions on the following matters should ensure that early action is taken when necessary and remove any uncertainty on the part of the officer of the watch:

(a) Precise instructions on calling the master; e.g.,

(i) Imminence of poor visibility.

(ii) Land not sighted by the expected time.

(iii) Failure of equipment (engine room, steering gear, radar, echo sounder, Decca *Navigator*, etc.).

(iv) Movements of any vessel in the vicinity likely to cause any danger.

(b) Posting look outs.

(c) Manning the wheel together with an established and regularly practiced drill for changing over from automatic to manual steering.

(d) Ensuring sufficient personnel are available in good time in special circumstances; e.g., reduced visibility and heavy traffic.

(e) Precise instructions on the immediate action to be taken if reduced visibility is encountered.

The issue of such instructions and intelligent compliance with them by the officer of the watch should do much to ensure that a potentially difficult situation has been anticipated and the ship is in a high degree of readiness to take the necessary action.

The two general terms used by the Chamber, "failure to keep a good lookout" and "weakness in bridge organization," lack the specificity necessary to develop a training system. An examination of the Chamber's meaning compared with the list of primary accident causes (appendix F) clearly establishes a relationship. The Chamber's term, "failure to keep a good lookout," includes not only the maintenance of a lookout in the generally accepted sense, but also a grasp of the situation. The present study is specific in the definition of accident causes to the degree required in developing learning/training objectives.

It is relevant that the most frequently appearing errors in the accident analyses were errors of omission rather than commission. Thus a tentative finding is that conning officers are not fully cognizant of their responsibilities, or they are not aware of the aids available and how to use them.

Secondary Cause is used to identify the contributory variables to each accident. It was not always possible to isolate these contributing variables. Note that a variable could be a primary factor in one accident and secondary in another, but is never both a primary and secondary factor in any single accident. In establishing learning and training objectives, both primary and secondary factors must be considered. For example command leadership includes training, setting example, application, and attention to detail. As a primary accident variable command leadership appears only 4.2 percent of the time, yet, as a contributory variable, it ranks second appearing 10.4 percent of the time. Thus, in any analysis of cause, command leadership should be a high priority candidate for inclusion in the training system.

Pilot On Board is used to identify the percentage of accidents occurring when a pilot was embarked and used. This factor when analyzed along with the two accident variables, overreliance on pilot and the identity of the conning officer, establishes a basis for estimating how pilots were actually used, and whether the conning officer used them in lieu of performing himself. In only 26 percent of all accidents was a pilot embarked, yet overreliance on this aid was a primary cause in 6.2 percent of the total accidents and a secondary cause in 6.7 percent of the total accidents.

Large Versus Small Vessel. Large to small vessel was defined as 10 to 1 in terms of displacement. Thirty-eight percent of all collisions were between large and small vessels with approximately 30 percent occurring either in the approaches to port, in a ship channel, or in the harbor. These statistics indicate that the attention of the conning officer, or his knowledge of the application of the rules of the road, are major issues in accidents involving large and small vessels. It is obvious that the conning officer must be well aware of all underway vessels surrounding him regardless of their size.

ANALYSIS OF NAVY ACCIDENTS

The previous discussions of the environmental and human factors were concerned with all ship handling accidents investigated. This analysis is restricted to those factors which contributed to Navy accidents. The human and environmental factors which contribute to Naval accidents give a good indication, when examined in conjunction with the elements required of a ship handler, of the subject matter necessary to be taught. Emphasis, and the depth to which each subject should be taught, is to be based on the analyses contained in this section. Tables 6 and 7 provided at the end of this section are summaries of each factor by accident type. Although data pertaining to Merchant Marine accidents are presented, only Navy data are discussed. These tables are designed as foldouts to permit continuous comparison with the discussion in the text. The reader is urged to fold out these tables at this time so that continuous reference can be made to them during the subsequent discussions.

COLLISIONS. Two types of collisions have been examined, and the applicable variables within each factor are considerably different. Most accidents involving a single underway vessel occurred in a harbor while approaching a stationary object (pier, jetty, another vessel, etc.). In contrast, the majority of collisions involving two underway vessels happened at sea, and 20 percent of these occurred during underway replenishment. Because of the intrinsic differences in location, with the consequent effect on conning procedures, each type of collision is discussed independently.

One Vessel Underway. Over 80 percent of all one vessel underway collisions occurred in two of the nine locations investigated. Forty-eight percent of the collisions occurred on approaches to stationary objects and thirty-four percent occurred in a harbor. From these statistics it is obvious that these two settings can be combined and emphasized in a single ship handling training situation. Wind, in 80 percent of the accidents, was no greater than can be expected in an exposed harbor; i.e., less than 16 knots, and in only 6 percent of the cases was the wind in excess of 27 knots. Over 80 percent of these accidents occurred under generally ideal conditions; i.e., daylight with good visibility, little to no current, and not an excessive wind. Human rather than environmental factors are the major factors which contributed to these accidents.

An analysis of the relationship between the conning officer, whether or not the CO was on the bridge for greater than 15 minutes, and the special sea detail is interesting and highly informative. Seventy-eight percent of the accidents occurred with the special sea detail set, which is the most competent ship handling crew on any Naval vessel. Over one-fourth of the accidents occurred when the CO had the con. In 92 percent of the accidents the CO had been on the bridge for greater than 15 minutes. Qualified OOD's and/or pilots were at the con in all but one

accident. The majority of these accidents occurred when the most highly qualified conning officers and/or the CO was in command.

Among the causes of these accidents, 40 percent of the time the primary variable was a failure to compensate for the forces acting on the ship (both external and internal). An additional 10 percent were attributed to a failure to use ground tackle properly, another 11.2 percent resulted from failure to grasp the significance of the situation, and 10 percent of the accidents were caused by a communications breakdown. Thus, 71.2 percent of the primary causes of these collisions were based on 5 variables. By adding a sixth variable, overreliance on a pilot, 80 percent of the primary causes are included. All variables are self-explanatory except ground tackle. For purposes of this study, ground tackle was expanded from the definitions of Crenshaw (1965) and Knights Modern Seamanship (1966) to include lines, tugs, and any other aid to mooring or holding a vessel.

Among the secondary, or contributory, causative variables, 5 occurred in over 75 percent of the accidents. These five were: a failure to grasp the situation; overreliance on a pilot; lack of command leadership; improper use of ground tackle; and communications breakdown. The number of instances in which a factor was of secondary cause, and in other instances a primary cause, is a strong indication of areas wherein conning officers and CO's exhibit a lack of comprehension or skill, and is indicative of the need for more training in that variable. No variable was a primary and a secondary cause in the same accident.

The variables which occurred as either a primary or secondary cause in a high percentage of cases are:

- Failure to grasp the situation
- Overreliance on pilot
- Improper use of ground tackle
- Communications breakdown

Of the total of 50 accidents studied, 38 percent (19 accidents) occurred with a pilot embarked and conning. This statistic was examined in conjunction with the two variables, the identity of the conning officer and the percentage of accidents which had overreliance on the pilot, as a primary or secondary cause. As a result it was found that the function of the pilot is not fully understood, or that his skills are improperly utilized. Further, since the pilot generally controls as opposed to acting as a consultant in the use of the ground tackle, particularly tugs, it becomes increasingly apparent that the ship handler requires special training in this area.

Two Vessels Underway. These collisions occurred primarily in the open sea although 25 percent happened in the ship channel leading into and inside harbors. Of the accidents which occurred in the open sea, 20.5 percent happened during the replenishment at sea evolution. With the exception of the amount of ambient light, the environmental conditions were excellent for better than 88 percent of the total accidents. In the collisions of this category one-third occurred during the hours of darkness as against only 4 percent for a single ship underway accident. Since the environment at the time of the accident was generally ideal, the human factors must be examined to identify the errors which led to the collisions.

Before delving into an analysis of the human factors, replenishment at sea requires some discussion. Replenishment at sea approaches the "worst case" of ships steaming in proximity, and it requires a high degree of competent ship handling. Efforts to develop automatic control systems for handling the internal forces to replace or supplement the conning officer have led to many independent studies and simulation efforts. The consensus of these studies is summarized by Vivar (1975).

> It has been demonstrated that the intrinsic dynamics of ships steaming at close proximity is unstable, the approach phase of the replenishment maneuver being of particular interest, where, excluding human intervention, collision is unavoidable.

The phrase "excluding human intervention" is the key to Vivar's conclusion. With respect to this study, it supports the finding that when two underway ships collide, the human factors have the greatest influence; i.e., human errors of omission. If these are controlled properly it is unlikely that a collision would occur.

The CO was found to be the conning officer in over 30 percent of the accidents, and was on the bridge more than 15 minutes in over 80 percent of the 2 underway vessel collisions. The Special Sea or a Special Maneuvering Detail was set in 22.2 percent of the 36 accidents. Thus, senior, experienced, and highly qualified officers were on the bridge during the majority of the reported collisions, and the most highly qualified team was controlling the ship almost one-fourth of the time. However, it must not be overlooked that in one-fifth of the cases the CO was not on the bridge. Thus in instances of steaming in the open sea only, it appears that conning officers sometimes require help but do not request it. The presence or absence of a pilot was not a major factor since none was embarked in 95 percent of the accidents.

The single greatest primary variable cause of these collisions was a failure to comply with the rules of the road (18.2 percent). This was followed by a failure to compensate for the external forces acting on

the ship and a failure to follow established doctrine (14.5 percent each), inattentive watch personnel (12.7 percent), and mechanical failures (10.9 percent). It is important to note that four of these five variables represent errors of omission. More familiarity with the rules of the road and tactical publications could have eliminated a large percentage of these collisions. Inattention on the part of conning officers suggests a less than adequate training program and insufficient supervision by responsible seniors. It was found that certified ship handlers either cannot compensate for the external forces acting on their ship or do not recognize the effect of these forces. These variables, and their frequency of occurrence, raise a question concerning the existing certification procedures: are they adequate?

Mechanical failure raises two issues: the capability of the conning officer to use the internal forces available to him to avoid accidents under adverse conditions and on-the-job training in emergency situations. The former issue cannot be offset by the incidence of accidents due solely to mechanical failure since accident reports which found this to be the sole primary cause were not used in the compilation of these statistics. An analysis of on-the-job training in emergency situations leads to the conclusion that insufficient command attention is directed to training in this area. Even though one of the primary variables of some accidents was mechanical failure, these cases inevitably included one or both of the following primary causes:

- Lack of command leadership indicating poor training for the entire ship handling team, or a weakness in the bridge organization.

- A communications breakdown in that the conning officer was not informed of the casualty, was informed too late, or received an incomplete report.

Secondary variables in these collisions were concentrated in four areas representing 56.4 percent of all contributory variables. These were: lack of command leadership, failure to grasp the situation, failure to follow established doctrine, and a communications breakdown. If failure to compensate for the forces acting on the ship (internal and external), inadequate use of available navigational aids, and the improper use of ground tackle are added, then over 91 percent of the variables in the accidents are covered. As in the case of one underway vessel no variables appeared in both the primary and secondary statistic for any one accident.

The variables which occurred as either a primary or secondary factor in a high percentage of cases are:

- Failure to follow established doctrine

- Failure to compensate for external forces
- Failure to grasp the situation
- Communications breakdown

Another special case deserves separate analysis. When the collision was between a large and a small vessel, special considerations apply. Although the rules of the road in their existing form make no distinction by size, it is apparent that some conning officers do. This is particularly true with respect to small, usually wooden, fishing vessels and pleasure craft. Cases were studied in which the conning officer proceeded on the assumption that, simply because of size, the larger vessel could usurp the right of way. When an in-extremis situation developed, the conning officer was unable to extricate his ship without damage. Thus we find the major variables in these situations to be a violation of the rules of the road and a failure to grasp the significance of the situation. Often these situations are compounded by a lack of command leadership and inattentiveness.

GROUNDINGS. Fifty-seven percent of the groundings occurred in a ship channel or restricted passage, and another 14.3 percent happened in a harbor. This means that 25 of the 35 groundings investigated were in restricted passages. Of the remaining, five (another 14.3 percent) occurred in open sea. That is, in these five accidents there was sufficient sea room, but the vessel attempted to pass too close to charted shoals or reefs.

The weather and sea conditions were ideal in over 70 percent of the groundings. In only 28.5 percent of the accidents was visibility under 1 nautical mile. Fog and rain squalls were present in 22.8 percent of the accidents. Wind was greater than 22 knots in only 17.6 percent of the groundings, and this factor evidenced itself primarily in the groundings which occurred when an anchored ship dragged or an underway vessel attempted to make a mooring. Current was a significant factor in only 8.6 percent of the groundings although conning officers too frequently failed to realize the effect of current, particularly when it exceeded 1 knot. However, the effect of current could have been overcome had the conning officer had a grasp of the significance of the situation. The environmental effects on groundings can be summarized as follows:

- The environment played no part in the majority (over 70 percent) of the groundings.

- Wind and current were factors which could have been eliminated by the recognition of the effect of these forces on the ship in a large percentage of the groundings.

- Poor or highly restricted visibility was a factor in only 17 percent of the groundings.

The conning officer was certified in every instance. CO's had the con in better than 30 percent and were on the bridge for over 15 minutes in approximately 80 percent of the groundings. One important point indicated by the statistics was that the CO was not on the bridge in approximately 18 percent of the groundings which could mean a weak bridge organization as defined by the Chamber of Shipping of the United Kingdom (1972b).

Four variables were dominant in the primary causes of groundings and accounted for 63.5 percent of the total. These were: an inadequate use of the available navigation aids (23.8 percent), a failure to take adequate fixes (17.5 percent), a lack of command leadership (12.7 percent), and a failure to follow established doctrine (9.5 percent). Scrutiny of these data indicates an interrelationship among these variables in that they all relate to a poor understanding of the responsibilities of command, either as CO or conning officer, and point toward a training deficiency. The fifth and sixth most frequent variables, a failure to grasp the situation and overreliance on the pilot, simply reemphasize this shortfall. The seventh most frequent variable, failure to compensate for the external forces acting on the ship, highlights a problem which appeared frequently in collisions. These seven causes account for 84 percent of the groundings.

Secondary causes are treated independently of the primary causes. In the case of groundings five variables account for better than 75 percent of the secondary cause factor. These five were: a failure to grasp the situation, a communications breakdown, an inadequate use of navigational aids, a failure to compensate for the external forces acting on the ship, and a lack of command leadership. It is interesting to note the number of times that a cause which is primary in one grounding is secondary in another.

The variables which occurred as either a primary or secondary factor in a high percentage of groundings are:

- Inadequate use of navigation aids
- Failure to grasp the situation
- Lack of command leadership
- Failure to take adequate fixes
- Failure to compensate for external forces

A pilot was embarked in slightly over 28 percent of the groundings, but overreliance on this pilot was either a primary or secondary cause only 6.2 percent of the time. When this percentage is compared to collisions with one vessel underway, it would appear that the use of a

pilot entering and leaving a harbor may be beneficial, but he probably should be used with caution when docking.

OTHER. Only five accidents, other than a collision or grounding, were included in the total studied. This sample size is considered too small to provide valid results; therefore, no attempt was made to perform an analysis. One useful conclusion can be derived from the low percentage (2.6 percent) of these accidents; i.e., the percentages are of such insignificance with respect to the overall accident rate that special training to correct for identified deficiencies must take a relatively low priority. Even without analysis, the causes of these accidents appear to parallel the causes of other types of accidents. Therefore, training to correct existing deficiencies in other types of accidents should be transferable into this category.

WAKE DAMAGE. Wake damage is unique in that it occurs only in highly restricted waters. In addition, the damage does not affect the underway vessel whose conning officer may not know he has caused damage. Reports of wake damage came exclusively from the JAG files of claims submitted against the United States (U.S. Navy).

In all instances, the underway vessel was proceeding at a rate of speed which caused excessive wakes for the surroundings. Other vessels, barges, camels, etc., moored in the stream or to piers were caused to heave into some stationary object. Some incidents caused sufficient heave that mooring lines were broken.

Three causes have been determined to be indicative of improper ship handling by the conning officer. No breakdown on a case-by-case basis was possible since the investigations were, for the most part, incomplete or inconclusive. The causal variables were:

- Violation of the rules of the road, usually the Inland or Western river version.

- Failure to follow established doctrine. This oversight on the part of conning officers most often applied to harbor regulations which had been amplified in doctrinal publications.

- Failure to grasp the situation.

Special training in wake effects to make conning officers aware of their responsibilities should not be required. A transfer of training should occur from the proposed training system.

SUM

ACCIDENT TYPE	TOTAL	TIME			WATCH							VISIBILITY									
	NO.	%			%							%									
	ACCIDENTS	DAYLIGHT	DUSK	NIGHT	MIDWATCH	MORNING	FORENOON	AFTERNOON	EVENING	FIRST	SEA DETAIL	CLEAR, UNLIMITED	SLIGHTLY REDUCED	REDUCED	POOR	NONE	SLIGHT HAZE	FOG PATCHES	DENSE FOG	NONE	
I. COLLISIONS																					
A. 1 UNDERWAY VESSEL																					
1.) NAVY	50	84.0	12.0	4.0	2.0	12.0	38.0	24.0	20.0	4.0	78.0	92.0	2.0	6.0	0	94.0	2.0	2.0	2.0	96.0	2.
2.) MERCHANT MARINE	22	72.7	9.1	18.2	4.5	13.6	22.7	45.5	4.5	9.1	NA	72.7	9.1	4.5	13.6	85.7	0	4.8	9.5	90.9	4.
B. 2 UNDERWAY VESSELS																					
1.) NAVY	36	58.3	8.3	33.3	13.9	8.3	27.8	19.4	13.9	16.7	22.2	88.6	5.7	5.7	0	94.3	2.9	2.9	0	100	
2.) MERCHANT MARINE	26	26.9	19.2	53.8	38.5	23.1	7.7	15.4	3.8	11.5	NA	23.1	7.7	23.1	46.2	34.6	0	11.5	53.8	84.6	3.
II. GROUNDINGS																					
A. NAVY	35	71.4	11.4	17.1	0	20.0	25.7	31.4	11.4	11.4	54.3	60.0	11.4	11.4	17.1	74.3	8.6	5.7	11.4	88.6	5.
B. MERCHANT MARINE	22	18.2	9.1	72.7	50.0	18.2	4.5	4.5	9.1	13.6	NA	59.1	27.3	9.1	4.5	86.4	9.1	0	4.5	68.2	
III. OTHER																					
A. NAVY	5	80.0	0	20.0	33.3	0	66.7	0	0	0	33.3	100	0	0	0	100	0	0	0	100	0

TABLE 6
ENVIRONMENTAL FACTORS
SUMMARY OF RESULTS BY TYPE ACCIDENT

ENVIRONMENTAL FACTORS

VISIBILITY % | FOG % | PRECIPITATION % | WIND FORCE % | CURRENT FORCE %

LIGHT HAZE	FOG PATCHES	DENSE FOG	NONE	DRIZZLE	HEAVY RAIN	RAIN SQUALLS	SNOW	CALM	1-3 KNOTS	4-6 KNOTS	7-10 KNOTS	11-16 KNOTS	17-21 KNOTS	22-27 KNOTS	28-33 KNOTS	34-40 KNOTS	OVER 40 KNOTS	LESS THAN 0.5 KNOTS	0.5-2.0 KNOTS	2.5-4.0 KNOTS	4.5-6.0 KNOTS	OVER 6.0 KNOTS	OPEN SEA	RESTRICTED PASSAGE	APPROACH TO PORT	IN SHIP CHANNEL	IN HARBOR	MANEUVERING IN ANCHORAGE	ANCHORED	UNDERWAY	
0	2.0	2.0	96.0	2.0	0	2.0	0	26.0	4.0	2.0	24.0	24.0	6.0	8.0	2.0	4.0	0	72.0	18.0	6.0	0	4.0	2.0	4.0	2.0	8.0	34.0	2.0	0	0	48.
0	4.8	9.5	90.9	4.5	0	4.5	0	36.4	4.5	4.5	18.2	9.1	9.1	0	4.5	9.1	4.5	86.4	13.6	0	0	0	4.3	8.7	8.7	4.3	34.8	8.7	8.7	0	21
9	2.9	0	100	0	0	0	0	28.6	0	8.6	31.4	17.1	11.4	2.9	0	0	0	97.2	0	2.8	0	0	45.5	2.3	4.5	9.1	15.9	2.3	0	20.5	
0	11.5	53.8	84.6	3.8	3.8	3.8	3.8	61.5	0	11.5	19.2	3.8	0	0	0	3.8	0	73.1	23.1	3.8	0	0	40.7	14.8	11.1	22.2	7.4	0	3.7	0	
6	5.7	11.4	88.6	5.7	0	5.7	0	44.1	0	11.8	5.9	11.8	8.8	8.8	5.9	2.9	0	65.7	25.7	8.6	0	0	14.3	20.0	0	37.1	14.3	0	5.7	0	8
1	0	4.5	68.2	0	4.5	22.7	4.5	31.8	4.5	13.6	4.5	0	4.5	13.6	13.6	9.1	4.5	72.7	13.6	13.6	0	0	3.8	26.9	34.6	19.2	3.8	7.7	3.8	0	
0	0	0	100	0	0	0	0	80.0	0	0	0	0	0	0	0	20.0	0	100	0	0	0	0	20.0	0	0	20.0	20.0	0	20.0	0	20

2

S
ACCIDENT

ENVIRONMENTAL FACTORS																					
PRECIPITATION	WIND FORCE								CURRENT FORCE					LOCATION							
%	%								%					%							
4-6 KNOTS	7-10 KNOTS	11-16 KNOTS	17-21 KNOTS	22-27 KNOTS	28-33 KNOTS	34-40 KNOTS	OVER 40 KNOTS	LESS THAN 0.5 KNOTS	0.5-2.0 KNOTS	2.5-4.0 KNOTS	4.5-6.0 KNOTS	OVER 6.0 KNOTS	OPEN SEA	RESTRICTED PASSAGE	APPROACH TO PORT	IN SHIP CHANNEL	IN HARBOR	MANEUVERING IN ANCHORAGE	ANCHORED	UNDERWAY REPLENISHMENT	APPROACH TO STATIONARY OBJECT
2.0	24.0	24.0	6.0	8.0	2.0	4.0	0	72.0	18.0	6.0	0	4.0	2.0	4.0	2.0	8.0	34.0	2.0	0	0	48.0
4.5	18.2	9.1	9.1	0	4.5	9.1	4.5	86.4	13.6	0	0	0	4.3	8.7	8.7	4.3	34.8	8.7	8.7	0	21.7
8.6	31.4	17.1	11.4	2.9	0	0	0	97.2	0	2.8	0	0	45.5	2.3	4.5	9.1	15.9	2.3	0	20.5	0
11.5	19.2	3.8	0	0	0	3.8	0	73.1	23.1	3.8	0	0	40.7	14.8	11.1	22.2	7.4	0	3.7	0	0
11.8	5.9	11.8	8.8	8.8	5.9	2.9	0	65.7	25.7	8.6	0	0	14.3	20.0	0	37.1	14.3	0	5.7	0	8.6
13.6	4.5	0	4.5	13.6	13.6	9.1	4.5	72.7	13.6	13.6	0	0	3.8	26.9	34.6	19.2	3.8	7.7	3.8	0	0
0	0	0	0	0	0	20.0	0	100	0	0	0	0	20.0	0	0	20.0	20.0	0	20.0	0	20.0

NOTE: 21 INCIDENTS INVOLVING WAKE DAMAGE NOT INCLUDED

3

ACCIDENT TYPE	TOTAL NO.	CONNING OFFICER %				CO ON BRIDGE %												
	ACCIDENT	CO (MASTER)	XO (FIRST OR SECOND OFFICER)	OTHER QUALIFIED WATCH OFFICER	UNQUALIFIED OFFICER	LESS THAN 5 MINUTES BEFORE INCIDENT	6-15 MINUTES BEFORE INCIDENT	MORE THAN 15 MINUTES BEFORE INCIDENT	NOT ON BRIDGE	RULES OF THE ROAD	FAILURE TO MAINTAIN ADEQUATE PLOT	FAILURE TO TAKE ADEQUATE FIXES	INADEQUATE USE OF NAVIGATION AIDS	FORCES ACTING ON SHIP INTERNAL	EXTERNAL FORCES ACTING ON SHIP	IMPROPER USE OF GROUND TA	FAILURE TO GRASP	FAILURE
I. COLLISIONS																		
A. 1 UNDERWAY VESSEL																		
1.) **NAVY**	50	26.0	0	72.0	2.0	0	0	92.0	8.0	2.5	0	1.2	3.8	12.5	27.5	10.0	11.2	1.2
2.) **MERCHANT MARINE**	22	27.3	4.5	68.2	0	0	0	81.8	18.2	10.0	0	3.3	10.0	3.3	23.3	13.3	3.3	3.3
B. 2 UNDERWAY VESSELS																		
1.) **NAVY**	36	30.6	0	69.4	0	0	0	80.6	19.4	18.2	0	1.8	0	3.6	14.5	1.8	9.1	1.8
2.) **MERCHANT MARINE**	26	7.7	19.2	73.1	0	7.7	7.7	73.1	11.5	54.1	10.8	0	2.7	0	0	0	10.8	10.8
II. GROUNDINGS																		
A. NAVY	35	31.4	0	68.6	0	0	2.9	79.4	17.6	0	0	17.5	23.8	3.2	7.9	3.2	6.3	0
B. MERCHANT MARINE	22	9.1	31.8	54.5	4.5	0	9.1	72.7	18.2	5.7	0	17.1	20.0	0	14.3	2.9	17.1	0
III. OTHER																		
A. NAVY	5	0	0	100	0	0	0	75.0	25.0	0	0	0	14.3	0	14.3	14.3	14.3	0

TABLE 7
HUMAN FACTORS
SUMMARY OF RESULTS BY TYPE ACCIDENT

HUMAN FACTORS

PRIMARY CAUSE

%

EXTERNAL FORCES ACTING ON SHIP	IMPROPER USE OF GROUND TACKLE	FAILURE TO GRASP THE SITUATION	FAILURE TO MAINTAIN ADEQUATE LOOKOUT	FAILURE TO MAINTAIN UP-TO-DATE CHARTS	COMMUNICATION BREAKDOWN	LACK OF COMMAND LEADERSHIP	INATTENTIVE WATCH PERSONNEL	OVERRELIANCE ON PILOT	OVERRELIANCE ON AIDS	MECHANICAL FAILURE	FAILURE TO FOLLOW ESTABLISHED DOCTRINE
27.5	10.0	11.2	1.2	0	10.0	2.5	0	8.8	0	3.8	5.0
23.3	13.3	3.3	3.3	3.3	3.3	3.3	0	10.0	6.7	3.3	0
4.5	1.8	9.1	1.8	0	5.5	1.8	12.7	3.6	0	10.9	14.5
0	0	10.8	10.8	0	0	0	0	5.4	5.4	0	0
7.9	3.2	6.3	0	0	4.8	12.7	0	6.3	3.2	1.6	9.5
4.3	2.9	17.1	0	2.9	2.9	2.9	0	2.9	5.7	5.7	0
.3	14.3	14.3	0	0	14.3	0	14.3	0	0	14.3	0

SECONDARY CAUSE

%

RULES OF THE ROAD	FAILURE TO MAINTAIN ADEQUATE PLOT	FAILURE TO TAKE ADEQUATE FIXES	INADEQUATE USE OF NAVIGATION AIDS	INTERNAL FORCES ACTING ON SHIP	EXTERNAL FORCES ACTING ON SHIP	IMPROPER USE OF GROUND TACKLE	FAILURE TO GRASP THE SITUATION	FAILURE TO MAINTAIN ADEQUATE LOOKOUT	FAILURE TO MAINTAIN UP-TO-DATE CHARTS	COMMUNICATION BREAKDOWN	LACK OF COMMAND LEADERSHIP	INATTENTIVE WATCH PERSONNEL	OVERRELIANCE ON PILOT	OVERRELIANCE ON AIDS	MECHANICAL FAILURE	FAILURE TO FOLLOW ESTA[BLISHED DOCTRINE]	YES	NO
2.9	0	0	0	0	8.8	14.7	17.6	0	0	11.8	14.7	0	17.6	0	8.8	2.9	38.0	62.0
5.9	0	5.9	11.8	5.9	0	17.6	5.9	5.9	0	23.5	0	0	11.8	0	5.9	0	27.3	72.7
0	0	4.3	8.7	8.7	8.7	8.7	13.0	0	0	13.0	17.4	0	0	0	4.3	13.0	5.6	94.4
8.0	28.0	0	4.0	0	4.0	0	8.0	0	0	12.0	0	0	0	20.0	12.0	4.0	30.8	69.2
0	0	3.0	15.2	3.0	12.1	3.0	21.2	0	0	18.2	9.1	0	6.1	3.0	0	6.1	28.6	71.4
0	0	13.8	17.2	0	6.9	3.4	3.4	0	0	17.2	17.2	0	0	10.3	10.3	0	18.2	81.8
0	0	0	0	0	0	50.0	0	0	0	0	0	0	50.0	0	0	0	40.0	60.0

2

E ACCIDENT

HUMAN FACTORS																						
SE		SECONDARY CAUSE																	PILOT ON BOARD		LARGE VERSUS SMALL VESSEL	
		%																	%		%	
MECHANICAL FAILURE	FAILURE TO FOLLOW ESTABLISHED DOCTRINE	RULES OF THE ROAD	FAILURE TO MAINTAIN ADEQUATE PLOT	FAILURE TO TAKE ADEQUATE FIXES	INADEQUATE USE OF NAVIGATION AIDS	INTERNAL FORCES ACTING ON SHIP	EXTERNAL FORCES ACTING ON SHIP	IMPROPER USE OF GROUND TACKLE	FAILURE TO GRASP THE SITUATION	FAILURE TO MAINTAIN ADEQUATE LOOKOUT	FAILURE TO MAINTAIN UP-TO-DATE CHARTS	COMMUNICATION BREAKDOWN	LACK OF COMMAND LEADERSHIP	INATTENTIVE WATCH PERSONNEL	OVERRELIANCE ON PILOT	OVERRELIANCE ON AIDS	MECHANICAL FAILURE	FAILURE TO FOLLOW ESTABLISHED DOCTRINE	YES	NO	YES	NO
3.8	5.0	2.9	0	0	0	0	8.8	14.7	17.6	0	0	11.8	14.7	0	17.6	0	8.8	2.9	38.0	62.0	NA	NA
3.3	0	5.9	0	5.9	11.8	5.9	0	17.6	5.9	5.9	0	23.5	0	0	11.8	0	5.9	0	27.3	72.7	NA	NA
.9	14.5	0	0	4.3	8.7	8.7	8.7	8.7	13.0	0	0	13.0	17.4	0	0	0	4.3	13.0	5.6	94.4	36.1	63.9
0	0	8.0	28.0	0	4.0	0	4.0	0	8.0	0	0	12.0	0	0	0	20.0	12.0	4.0	30.8	69.2	42.3	57.7
.6	9.5	0	0	3.0	15.2	3.0	12.1	3.0	21.2	0	0	18.2	9.1	0	6.1	3.0	0	6.1	28.6	71.4	NA	NA
.7	0	0	0	13.8	17.2	0	6.9	3.4	3.4	0	0	17.2	17.2	0	0	10.3	10.3	0	18.2	81.8	NA	NA
.3	0	0	0	0	0	0	0	50.0	0	0	0	0	0	0	50.0	0	0	0	40.0	60.0	NA	NA

NOTE: 21 INCIDENTS INVOLVING WAKE DAMAGE NOT INCLUDED.

3

SECTION IV

EXISTING TRAINING

Naval ship handling training, for officer accessions other than through the U.S. Naval Academy, has been predominately on-the-job training conducted by senior officers aboard operational ships. Some classroom time is available at the FTC's, or amphibious schools, but this usually is restricted to a few isolated courses.

SUMMARY

An investigation of existing ship handling training is made on a course-by-course basis. It was found that the basic schooling falls short of the Navy's needs and does not emphasize skills or the integration of the knowledge elements which are required by a ship handler. Training for the intermediate and senior officers is primarily refresher in terms of the OOD's tasks, and depends upon on-the-job follow-on training for many of the knowledge elements and most of the skills. There appears to be a lack of coordination between courses and between schools so that learning of the knowledge elements is nonstandard. Transition training is nonexistent.

Training aids and devices are used to support existing ship handling training programs. However, the full potential of these aids and devices is not always realized due to improper utilization or failure to exploit all of their capabilities. New training aids and devices may be the solution to voids which now exist in certain skill training areas. Devices are required which match skill training to ship class, thereby preparing the trainee for the handling characteristics of the vessel to which he is ordered.

DISCUSSION

OCS exposes the student to the requirements of an OOD, but does not specifically address ship handling. NROTC accessions receive almost no exposure to ship handling. Since both of these categories of potential unrestricted line officers are expected to qualify within a relatively short time of reporting aboard their first ship, they are at a distinct disadvantage.

In recognition of this disadvantage, and because of the continuing high accident rate, a Basic Course which included limited ship handling training was developed at the Surface Warfare Officers School (SWOS) for all new accessions. The present investigation examined the curriculum at OCS in conjunction with the Basic Course at SWOS to determine which ship handling elements are taught and the depth of coverage of each subject. Other Navy training was investigated. Training was categorized as basic ship handling for JO's or advanced training for intermediate category officers depending upon the entry requirements for the individual courses.

Ship handling training for Coast Guard and Merchant Marine officers was examined to the degree that it could be compared to Navy training. Particular attention was paid to the presentation of skill training and how it was integrated with the basic knowledges taught.

Existing U.S. Navy and non-U.S. Navy ship handling training programs are discussed in the following paragraphs.

U.S. NAVY

Ship handling training is conducted at five locations in six schools excluding the U.S. Naval Academy which was not investigated. Newport, Rhode Island, is the location for training classes held at the OCS and SWOS. The Amphibious School, Little Creek, Virginia, conducts junior and senior officer courses, and holds training for PCO's/PXO's in the sit-in models on Lake Chubb. Fleet Training Center, Mayport, Florida, conducts junior and senior officer courses and has acquired a number of sailboats for their recently instituted sailing classes for JO's and chief petty officers. FTC, San Diego, California, holds classes similar to those conducted at the Amphibious School, Little Creek, Virginia, but does not have sit-in models. SWOS, Coronado, California, conducts classes similar to those held at SWOS, Newport, Rhode Island. Each of the existing training schools was visited and is discussed independently.

BASIC COURSE.

OCS, Newport, RI. Approximately 60 hours are devoted to subjects which are closely related to the knowledge elements identified in section II of this report. Of that total, 27 hours are assigned to navigation and piloting and 12 hours to relative motion which includes the maneuvering board. No subject area is covered beyond the introductory phase.

The four YP's based in Newport are scheduled to be available to the OCS for introductory cruises. Classes have a maximum of 6 hours (1 day) underway time available although not everyone in each class, and not all classes, have the opportunity to spend a day underway. Scheduling of OCS introductory cruises is secondary to SWOS and Fleet Ballistic Missile (FBM) Submarine crew scheduling; therefore, the YP's are available only if SWOS or the FBM crews do not require them. Weather, at certain times of the year, is a controlling factor. Even when the boats are scheduled for OCS use, weather frequently causes cancellation.

The radio controlled ship models, Device 1DA5, are not scheduled for use by OCS students.

Interviewees stated that graduates of the OCS have little to no appreciation of the problems associated with ship handling. Upon graduation they are not qualified for an under-instruction billet on the bridge of an operational ship. Discussions with OCS training personnel confirm this assessment. However, graduates proceeding to the Fleets are sent via SWOS where they take the Basic Course.

SWOS, Newport, RI, and Coronado, CA. The two SWOS's follow almost identical curricula, therefore, they will be discussed as one school. One major difference between them lies in the class of small craft used for skill training. Another difference lies in the lack of radio controlled ship models, Device 1DA5, at Coronado.

The Basic SWOS Course includes 88 hours on ship handling subjects in the classroom, 68 hours on Device 1DA5 (Newport only), and a total of 40 hours on a small craft or in a simulator. Twenty-two classroom hours are spent studying navigation and piloting, 18 hours on relative motion, 10 hours on the rules of the road, and 10 hours on tactical publications. This leaves only 28 hours for all other knowledge elements required of conning officers.

Some reinforcement of classroom teaching of the concept of relative motion and the forces acting on a ship is accomplished on Device 1DA5 at Newport. Such factors as class size, distance between the SWOS and device buildings, method of scheduling, and instruction techniques used have an adverse impact upon the learning process. The knowledge obtained in this type of context may not only lack utility but may, in fact, be inappropriate or incorrect. It is important that no neophyte ship handler be permitted to use Device 1DA5 without a qualified, school-assigned, ship handling instructor being present. The TRADEVMAN on duty usually oversees the use of this device. Observations led to the conclusion that the TRADEVMAN is overburdened with maintenance work and does not fully understand the complexities of ship handling. Thus, he cannot fulfill the instructor slot; trainees learn the "trick" of maneuvering models without learning the principles involved.

A simulator, incorporating a simulated CIC and a simulated bridge, is used to a great extent as a hands-on trainer and to teach team coordination. Exercises are basic in nature. The trainees are programed to complete this phase with an understanding of the use of CIC as an aid to the OOD. However, as a result of discussions, it appears probable that students complete these exercises with the incorrect idea that CIC is a substitute for, rather than an aid to, the conning officer.

Each SWOS Basic class is scheduled for 40 hours skill training aboard a small craft or in a bridge/CIC simulator type of device. At Coronado, the boats are ex-river minesweepers reconstructed by the school; at Newport, they are YP's. Both type boats are twin screw with twin rudders, highly maneuverable, and with very fast reaction to a change of the internal forces (change of revolutions per minute or rudder angle). Neither boat can be operated as a single screw craft either at relatively low speeds or in a backing mode because the rudder cannot overcome the twisting force of the propeller. Both classes of boats are equipped with radar, a gyro which drives both the steering compass and a repeater, and radio equipment. The YP's have sophisticated navigation equipment, extensive plotting facilities, and messing and berthing space which the utility boats do not have. Two observations are appropriate.

- The YP's have equipment far in excess of the needs of a simple ship handling skill trainer. The utility boats have adequate equipment, but do not have sufficient plotting room. It was observed that neither craft has adequate space on the flying bridge for observers. Both classes of craft are used exclusively for ship handling training and harbor piloting. Neither class of vessel is used, nor is it planned to use them, for any other purpose. It is not possible to use either craft to illustrate the handling differences between a single and a multiple screw vessel.

- Students man only the conning stations (OOD and JOOW). Assigned school or squadron personnel handle all other functions performed by the ship handling team. This means there is a large amount of dead time, and with the small bridge area available, very few students can observe and receive instruction while others are conning.

DEPARTMENT HEAD COURSE.

SWOS, Newport, RI, and Coronado, CA. The Department Head course is designed for qualified OOD's; i.e., certified ship handlers, en route from their first shore duty to their second sea duty tour. Three branches of the course are available--operations, engineering, and gunnery--and the student follows the applicable branch. The mission of the school does not include the teaching of ship handling per se although trainees do receive some closely related instruction as they pursue the OOD units of the course.

An instructional unit is devoted to rules of the road, another to seamanship, and a third to navigation and piloting. Peripheral training which is closely related to ship handling and special cases, such as underway replenishment, is given scant attention. Time is spent on the radio controlled ship models (not available in Coronado, CA.) and in the simulator. These devices do reinforce the knowledge elements of ship characteristics and relative motion. However, since the emphasis in this course lies in the technical and administrative duties of a department head, this phase serves as refresher training rather than presenting new material. Some excellent hands-on skill training is obtained in the small craft. Subjects covered include elementary tactics, piloting, and basic maneuvers. Much valuable training time is lost and effective knowledge reinforcement is not accomplished due to (1) the numbers of students; (2) the failure, either through scheduling or because of a lack of facilities, to combine elements of skill training; and (3) the failure to assign students to all positions (helm, lee helm, talkers, etc.).

It was found that, in general, the Department Head Course is excellent in teaching most of the duties of a technical supervisor, personnel manager, and administrator, but ship handling is not taught.

PCO/PXO COURSE. As structured, the PCO/PXO Course provides an overview of the duties and responsibilities of a CO. Some review in the areas of seamanship, navigation and piloting, and rules of the road is presented. Heavy emphasis is placed on the area currently providing the greatest numbers of casualties to the Navy (at this time it is engineering).

Device 1DA5 is scheduled for a short period as a means of reinforcing and recalling knowledges, and the facilities are open and available to trainees during nonschool hours. At Newport, aviators in particular make heavy use of this device outside of the regular working day. Skill training aboard the small craft does occur, but not to a significant degree.

As with the Department Head Course, this period of schooling is excellent for its designed purpose; i.e., training managers and refreshing long dormant administrative and doctrinal policies. It does not provide either advanced ship handling training for PXO's or adequate refresher ship handling training for PCO's.

AMPHIBIOUS SCHOOL, LITTLE CREEK, VA, AND FTC, SAN DIEGO, CA. The ship to Shore Department of the Amphibious School conducts three formal courses for OOD's. Entrants are expected to be qualified OODs's; however, school personnel have stated that this is not always the case. These courses are paralleled on the West Coast by the FTC, San Diego. Two of the courses--Junior Officer Ship Handling and Rules of the Road--are well attended; the third, OOD tactics, is not. These are updating courses designed to raise the proficiency of qualified personnel in areas they have already learned. The Junior Officer Ship Handling Course is the only one offering skill enhancement. Approximately 75 percent of the time is spent on Device 1DA5 at both schools, or, at the Amphibious School, in sit-in scaled ship models on Lake Chubb. None of the courses is given in sufficient detail to fulfill the needs of an uncertified officer. The course objectives lie in the general OOD responsibility areas rather than with the specific ship handling portion of a OOD's task.

Some discussion of the sit-in models is appropriate. These craft are designed to react on a 1 to 4 scale of the ships they represent. The scaling effect applies to both acceleration/deceleration and reaction to the rudder. However, school personnel state that external forces, such as wind and current, act on the models as if they were four times the actual force. This means that a 10 knot wind acts on the model as if it were 40 knots on the actual ship. In addition to the problems associated with external forces, the conning officer is seated in a cockpit well forward. His view aft is negligible and perspective is distorted. The model is physically scaled to approximately 25 to 1, reaction to internal forces is 4 to 1, reaction to external forces is 1 to 4, buoys and lake objects used in conjunction with the model are a different, nonspecific scale, and land objects used for reference and

ranges are normal size. The handling of any craft can be beneficial to prospective conning officers, but the value return for investment, maintenance costs, and resource expenditure (time and personnel) is an unknown and questionable quantity.

A prospective Officer of the Deck Course is conducted at FTC, San Diego. The mission of this course is, "to prepare Naval officers for rapid qualification as officers of the deck in port, during independent and formation steaming in surface ships under normal steaming conditions. Qualification as officer of the deck is a function of command." (Curriculum Outline, Prospective Officer of the Deck, Undated). Much of this course parallels the SWOS Basic Course in that basic knowledge is taught, then reinforced through the use of training devices. As with the SWOS Basic Course, the depth to which each subject area is presented is considered to be less than is required by apprentice ship handlers.

FTC, MAYPORT, FL. The three courses taught at the Amphibious School, Little Creek, are also taught at FTC, Mayport. These courses are either basic and introductory or update in nature. However, because of the problems associated with the recognition of the effect of external forces acting on a ship, a Basic Sailing Seamanship Course has been instituted. This course is designed for JO's and senior petty officers. As of the date of report preparation no students had attended, but senior officers and prospective instructors were interviewed about the course and the course outline was examined.

Sailing is considered to be an excellent method of introducing persons to the effects of wind and current. One cannot sail successfully without learning to compensate for these external forces. However, this course is designed as a 1-week course and covers only the basics of sailing, nomenclature, and rigging. In order to become fully proficient in the art of boat handling, and to reach the stage wherein relative motion recognition becomes automatic, much more actual sailing time is required. The time required to learn sailing to the necessary degree is practical for midshipmen at the U.S. Naval Academy over the 4-year attendance period, but not for NROTC and OCS students without an increase in the time spent on active duty for training or at the basic school. Post NROTC/OCS graduation ashore school time is minimal and the addition of time to teach sailing is not feasible. In considering the small numbers of students who can occupy one boat, the facilities and grounds necessary to maintain a sailboat fleet, and the resources which would have to be devoted to this type of training, it is questionable whether value would be obtained commensurate with expenditure.

There is an alternative for the use of sailboats for training, and that is the maintenance of a fleet in major port areas for the use of JO's assigned to operational units. Prior to making a decision on this approach, a study would be required to determine annual costs, startup

costs, other resources required, and an estimated use factor. These could then be weighed against the anticipated benefits. The Mayport installation could be used as a pilot program to determine whether return on investment would warrant the expenditure.

NON-U.S. NAVY

U.S. COAST GUARD. OCS training for the U.S. Coast Guard is conducted at Yorktown, Virginia. There is little difference between the methods and depth of training of Coast Guard accessions and the Navy's OCS/SWOS Basic combination. The Coast Guard mission dictates different areas of emphasis than Navy OCS training.

One notable difference is the method of presenting skill training. A 125 foot cutter has been assigned to the school for the purpose of training potential JO's. This ship is used for bumper and docking drills with candidates acting as both OOD and JOOW. The vessel is dedicated to this training, and bumps, dents, and scraped paint are accepted as training costs. Subsequent to the time spent on the dedicated cutter, all candidates are assigned to another dedicated operating ship for a week of practical operating experience. Excluding engineering watches, all stations are manned by the officer students during both types of skill training. Therefore, graduates have obtained knowledge and practiced skills in a situation very closely related to operational conditions. In addition, they have had the opportunity to develop an understanding of the problems faced by other members of the ship handling team, thus they are in a good position to train the team.

Two differences exist between the U.S. Coast Guard and the Navy officer accession systems which make this dedicated ship concept both economical and feasible for the Coast Guard.

- There are only two classes per year graduated by the Coast Guard; each class consists of 90 to 100 persons. The classes are not simultaneous.

- No advanced or refresher classes are conducted in ship handling, therefore there is no scheduling problem.

U.S. MERCHANT MARINE. "In the marine area, officer training begins in the maritime academies.... From then, training is generally on-the-job in nature, and relatively few ship owners have any formalized in-house training programs. Some marine operators have utilized ship model training and more recently, marine simulator training to teach ship handling " (Schumacker, Madsen, and Nicastro, 1972). This statement, made at the 17th Annual Tanker Conference, illustrates a changing philosophy towards training by the Merchant Service. Shore-based simulators are coming into use to supplement on-the-job training.

Initial schooling parallels that given at the U.S. Naval Academy, the major differences being the amount of time spent at sea, and emphasis. Deck officers are not required to become qualified outside of their field (engineering, communications), and a large proportion of the time is devoted to the handling and storage of cargo. Initial certification is done by the Coast Guard based on a series of written examinations. Advancement is based on time at sea, time in rank, and a written examination given by the U.S. Government. No practical demonstration of skill capabilities is required.

Until recently all postgraduate training has been on-the-job; however, this practice has changed in recent years. Accident rates and changing ship characteristics are a cause of concern to ship owners and maritime unions. To provide a measure of advanced training, two simulators have been installed on the East Coast, one operated under the auspices of the Masters, Mates, and Pilots Union at Baltimore, Maryland, and the other operated by Marine Safety International at Flushing, New York. The former is a point-to-point steaming trainer which emphasizes situations encountered during routine transits. As such, it is primarily an update or refresher trainer for conning rather than a ship handling trainer. The latter trainer is used to provide transition training for Merchant Marine masters assuming, or in, command of super tankers and liquid natural gas ships. This trainer is designed to familiarize the conning officer with the characteristics of these unwieldy vessels as they enter port and, subsequently, dock. Thus, it could be considered a ship handling trainer in an extremely restricted setting.

The National Maritime Research Center has installed a highly sophisticated simulator designed to evaluate ship handling techniques. This device, CAORF, using computer generated imagery, has the capability of providing almost any maritime setting desired. However, CAORF is a research tool rather than a trainer. It has the capability of being degraded or upgraded in any specified area, and could be used to evaluate the degree of realism required of a ship handling simulator.

FOREIGN. Two foreign countries have developed simulators for certain aspects of ship handling training. The Netherlands was the leader having constructed the first simulator used by the Merchant Marine. Shortly after this device was placed in operation, West Germany installed a training facility which included a simulator for her Merchant Marine officers. It has not been possible to examine these devices. However, they are primarily point-to-point transit trainers with minor ship handling training capabilities. A general discussion of these devices is presented by Zade, (1974) and Bagley, (1972).

ANALYSIS

BASIC TRAINING. Initial ship handling training conducted by the U.S. Navy exposes the OCS student to a majority of the knowledge elements required of a competent ship handler. No effective skill training is

provided. Subsequent schooling at the SWOS, which is required of all unrestricted line officers, reinforces the initial knowledge training, and delves into these same elements to greater depth. Some training using aids and devices is provided, but it can be classified, at best, as familiarization rather than skill training. This means the Navy expects its potential conning officers to learn ship handling principles in the classroom and to apply these principles in an operational setting without benefit of formal skill training. At the National Air Transportation meeting, Shumway (1971) stated the following:

> In 1967 at the SAE International meeting in New York, John Koch exhibited a chart that showed learning proficiency for various stimuli:
>
> Learning Proficiency
>
> 90% if we can do it
> 70% if we can say it
> 50% of what we see and hear
> 30% of what we see
> 20% of what we hear
> 10% of what we read
>
> This chart shows that "Learning by Doing" is the most efficient approach to learning. As our experience agrees with this we decided to emphasize this approach. The ideal place to teach "Learning by Doing" is in the cockpit. The idea of a "Cockpit Classroom" evolved from this exercise.... This approach combines the most effective techniques and should result in a significant reduction in training time.

Although Shumway was addressing pilot training, the criteria of learning proficiency expounded and the concept of doing apply to any situation where the operator must perform. Navy ship handling training does not now require the student to perform sufficiently to acquire a reasonable degree of proficiency either in a simulator ("Cockpit classroom") or on ship or boat.

In section II of this report 14 individual knowledge/skill elements were identified. The combination of OCS/SWOS Basic Course actually addresses, to varying degrees, only 10 of these factors. Those not included in the curriculum are:

Planning Ahead
The Ship Team
Thumb Rules
Other Ship Characteristics

Some elements are not adequately emphasized or presented so that retention by the student is insured. Others, which require skill training to insure a complete understanding of the subject, are presented only in the classroom. A prime example is the use of ground tackle (including the use of tugs and pilots). In the combined schooling only 8 hours are allocated to this element in the classroom, and no skill training time is scheduled. Training beyond the basic course does not include ground tackle.

It has been found that basic ship handling training for Naval officers is not fully coordinated and integrated. Bits and pieces are covered, but they are not drawn into a composite picture. The trainee leaves the Basic Course with fragmentary knowledge elements and few, if any, skills.

INTERMEDIATE TRAINING. Existing intermediate training is designed for technical supervisors, personnel managers, and administrators; ship handling receives scant attention. Classroom training is predominately refresher in tone, and skill training is at basic levels. The emphasis in skill training lies in those areas which should have been mastered prior to being certified as a qualified OOD.

The PCO/PXO course is totally refresher in the ship handling phases. This situation is adequate for officers who have completed the Command Qualification Board, but is questionable for PXO's. Officers who have not been certified as qualified to command are in a training situation and should receive that training which can be given in a shore environment to prepare them for the Command Qualification Board.

TRANSITION TRAINING. No formal shore-based transition training exists in the Navy. Officers who have had extensive experience at sea, regardless of classes of ships they have served on, expressed the opinion that this type of exposure would be beneficial, but should not be mandatory. Officers whose seagoing experience has been limited thought this type of training should be mandatory. It was not possible to determine the experience level of the CO's and conning officers of the ships involved in accidents. As a consequence no firm findings can be made with respect to the existing situation and need for transition training.

A significant proportion of the middle grade officers occupying responsible billets is serving split tours immediately following graduation from the SWOS Department Head Course. They proceed from a highly maneuverable, well powered combatant vessel to a cumbersome, frequently underpowered amphibious or service force vessel. The handling characteristics are at the two extremes. Senior Naval officers of the rank of Captain command an auxiliary vessel and advance to a carrier type. Again, ships of widely different characteristics. In neither situation is transition without training warranted or justified, particularly when one weighs

the cost of a few days transition training against the costs incurred by one major accident and the possible loss of life.

Extreme differences in ship characteristics present problems which closely parallel those encountered by aviators when transitioning from one type of aircraft to another wherein functional and handling characteristics differ widely. Experience, practice, skill, and "luck" may enable an officer to successfully transition from ship to ship and even aircraft to aircraft. However, as the aviation community has proven by their own successful transition programs, it is not prudent to base qualification on chance. The training techniques and philosophies of the aviation community regarding transition training have direct application to the surface community. Formal transition training should be established for SWO's transitioning from ship class to ship class.

REFRESHER TRAINING. There are a series of courses which do provide limited refresher training for qualified OOD's. However, with the exception of rules of the road, this training is directed toward the general OOD rather than the ship handler duties. The training is uncoordinated and provides only a minimum of skill training. Some noticeable differences have been found between teaching emphasis at different schools which leads to a lack of standardization.

SECTION V

PROPOSED SHIP HANDLING TRAINING SYSTEM

This section develops the concept for an integrated ship handling training system by proposing a system model, stating course objectives, and identifying required training aids and devices.

SUMMARY

This section synthesizes the findings of the analyses discussed in prior sections of this report to develop a proposed ship handling training system. A training concept is presented which differentiates between the degree of learning required at various stages of a Naval officer's career. Three courses are specified as required: a Basic Course for new accessions, a Department Head Course for recently qualified OOD's, and a PCO/PXO Course for officers assigned to command or executive officer billets. In additon, advanced category officers and intermediate category officers would have available optional refresher and transition training.

Twelve learning modules are proposed, each module being composed of three submodules. The module incorporates the required knowledge elements, while the submodule specifies in which course and to what depth the subject will be addressed. A priority scheme is developed by applying weighted factors to determine the importance of each learning module. Based on the priority, certain modules are specified as required to be taught in the shore-based courses, while others are determined to be capable of being learned by other means.

The three required courses of instruction are examined and learning objectives developed for each course. To insure trainees absorbed the requisite knowledge and skills, existing and proposed devices are discussed as they relate to the learning module. The applicability of each device is classified by its importance to the acquisition of the requisite knowledge and skills.

DISCUSSION

Required ship handling training can be divided into three distinct types; basic, intermediate, and advanced. Basic training is that which JO's receive prior to being certified as qualified OOD's. There is no facility ashore which can qualify an officer in ship handling; this and certification must be done by that officer's CO aboard an operating ship. Thus, proposed basic training requires a schoolhouse phase and an operational phase. Intermediate training should commence when the officer receives his OOD qualifying letter and continue through the

individual officer's certification by the Command Qualification Board as qualified to command. Two schoolhouse periods are required during the intermediate phase, although there may be others which are made available on an "as needed" basis. Advanced training should consist of refresher and/or transition training. No distinct advanced training schooling is required.

PROPOSED TRAINING SYSTEM

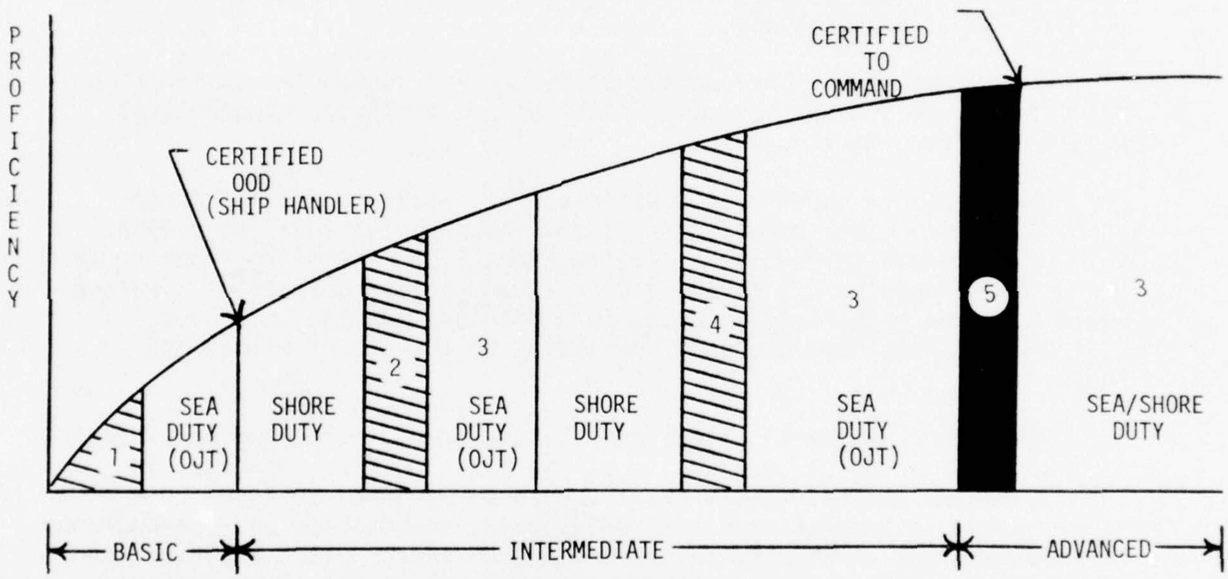
SYSTEM CONCEPT. The knowledge and skill elements required of a ship handler do not vary with his level of proficiency. The difference in the level of ship handling lies in the depth of capability in handling a ship, and planning. The officer in the basic category has a lesser required depth of capability than an officer in the intermediate category, and very few planning functions. He is, therefore, trained only to the level of proficiency necessary to prepare him for on-the-job training prior to proceeding to an operational unit. An intermediate category officer will have attained a high degree of competency for ship handling in any given situation, but will not have attained the planning and operational capabilities of an officer who has reached the advanced status. Officers in the intermediate category will attend two required shore-based courses to enhance their knowledge and skills. These are the Department Head Course and the PCO/PXO Course. Figure 4 illustrates this training system concept and the anticipated career progression of an officer who aspires to command at sea.

The PCO/PXO Course is to serve a dual function. For the prospective executive officer it will provide advanced training which emphasizes planning as well as operations, while for the prospective CO it will serve as a refresher course. Thus, both the intermediate and the advanced categories of officer may be in attendance at this course simultaneously.

Officers in the advanced category will have available two types of training, refresher and transition. Both are optional to be made available at the discretion of the Type Commander.

SYSTEM BOUNDARIES. The ship handling training system must address the decisions and actions of the conning officer in the situation itself and those functions which, if ignored, may cause a conning officer to place a vessel in an in-extremis or in a dangerous situation. In section II of this report, a large number of ancillary skills and broad knowledge in specific areas have been identified as required. Thus the boundaries of the proposed system are established to include an in-extremis or dangerous situation and how the conning officer arrived in this situation.

INSTRUCTIONAL MODULES. The proposed training system is to be composed of modules of instruction, each directed to a specific subject area. Every module is to consist of three submodules, each applicable to a



A. ENTRY LEVEL: OCS OR NROTC OR USNA

① Basic Training

② Department Head Training

③ Transition and/or Refresher Training as Required

④ PCO/PXO Training

⑤ Command Qualification Board

Figure 4. Career Progression to Command Typical Surface Naval Officer

specific required course. The first submodule will include only that information necessary for an officer in the basic category. The second will encompass all knowledge and skill elements required of a graduate of the Department Head Course, and the third will be directed toward the PCO/PXO Course. Figure 5 illustrates the concept.

All submodules are to be built of units of instruction, each of which covers an independent topic. The sum of the units includes all of the information needed by an officer in the appropriate category. The final breakdown is the bit. The bit is defined as the smallest division of a learning module; it consists of discrete pieces of related information in a specific subject area. Course developers should use the bit in the formulation of lesson plans.

For an example of the concept of module and submodule construction refer to figure 6. The following discussion describes a hypothetical module on ground tackle.

The submodule covering the Basic Course, would consist of three units of instruction, use of the anchor, mooring, and tugs and pilots. Unit A would have three bits of instruction; i.e., anchoring, mooring to two anchors, and the use of the anchor in amphibious operations. Unit B would have two bits; i.e., mooring to a pier and mooring to a buoy. Unit C would also have two bits consisting of the use of pilots and tugs.

The second submodule, Department Head Course, would consist of the similar three units of instruction as the Basic Course. However, in unit D, bit 8, anchoring, the detail would be expanded to cover such items as the interrelationship of navigation, seamanship, and oceanography to ship handling as relates to the conning officer. Bit 9 would go into the details of the two types of two anchor moors. Bit 10 would cover details of the environment, broaching, etc. A new bit would be added to address the use of the anchor as an aid to maneuvering ("San Francisco Tug"). Unit E would expand on bits 4 and 5, and would include a new third bit which teaches the use of lines for purposes other than mooring. Unit F would simply expand the prior lessons on tugs and pilots to the completion of the necessary knowledge elements in this area. Insofar as is possible, this submodule would include as much skill training time in a simulator or on a small craft as is possible. It is anticipated that as each interrelated bit between modules is completed in the classroom, students would be required to apply the learning on a training aid or device thereby reinforcing the learning and acquiring an appreciation of the intricate interrelationship of the various elements.

The last submodule, PCO/PXO Course, would differ slightly from the previous submodules in that the knowledge elements would have been

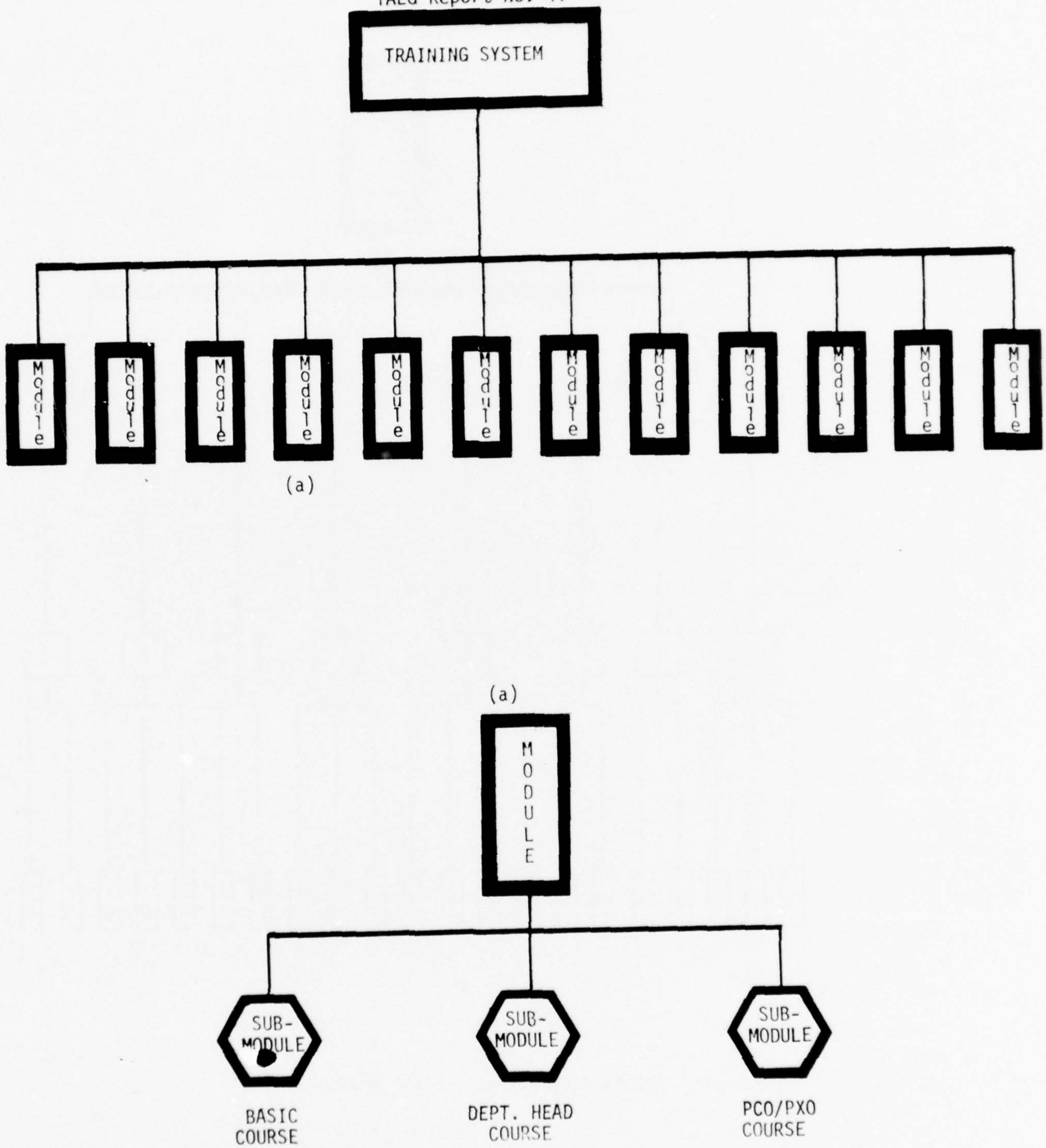


Figure 5. Proposed Ship Handling Training System Module Concept

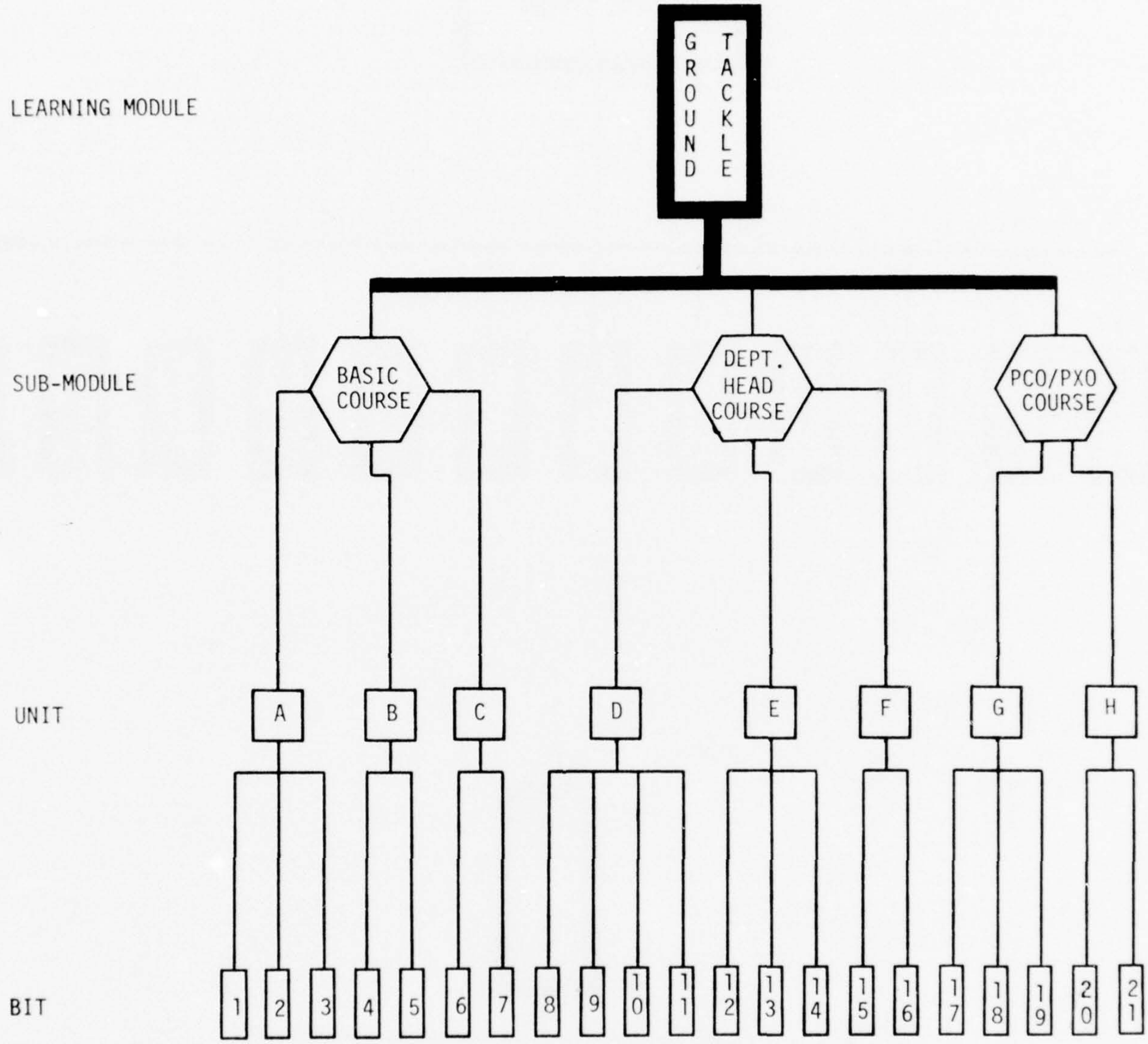


Figure 6. Hypothetical Ground Tackle Module

completed prior to arrival at the schoolhouse. Two new units would appear: unit G, refresher training, and unit H, planning for the use of ground tackle. Unit G would have bits extracted from prior training covering anchoring, mooring, and pilots and tugs. Unit H would emphasize the planning phase of evolutions which would require the use of ground tackle.

Section II of this report identifies the baseline knowledge and skill elements necessary in the development of modules of instruction. In addition to providing training for these elements, there is a need to integrate in the mind of the trainee an interrelationship of the acquired knowledge and skills, and to insure the trainee understands the interaction of the individual elements. Thus, one module, in addition to those derived from the baseline, will be required to perform the function of integration.

As has been indicated in figure 4, there are but three required ship handling ashore schooling periods. Consequently, only three submodules are required for each module of instruction; one for each level of proficiency. Optional refresher and transition training requirements will be satisfied by drawing on the appropriate submodule and extracting specific units or bits of instruction as appropriate.

The 14 knowledge elements identified in figure 2 will not require 14 modules of instruction. Certain of the elements can best be taught in conjunction with other elements to which they bear a close relationship. The following combinations of knowledge elements are proposed.

- Combine element 5, Ship Characteristics, with element 13, Other Ship Characteristics. It is intended that ship characteristics cover the operating characteristics of Navy ships which should be known by conning officers. Other ship characteristics is intended to emphasize merchant vessels most often encountered, and unique features of Naval vessels not included in the usual connotation of ship characteristics.

- Combine element 8, Meteorology, and element 12, Oceanography, since the condition of one influences the condition of the other. A conning officer must consider these two concurrently in estimating the external forces operating on his ship.

- Combine element 10, Tactical Publications, with element 11, Thumb Rules. It is in the study of tactical maneuvers and replenishment at sea that the greatest use is made of thumb rules. Therefore, this would be an ideal place to introduce them.

Course developers should construct each module independently, but with an intent towards the future integration of modules. Instructional time is of secondary importance. Information contained in any bit should be based solely on a need-to-know. No nice-to-know, such as historical or related but not required, information should be incorporated. Skill training must be integral to each bit developed. When all submodules have been developed, then, and only then, can an inspection of the skill training component be made with the aim of combining those elements which lend themselves to being taught simultaneously. To illustrate, docking drills on a small craft can be used as skill training in at least four learning module areas, external and internal ship forces, ground tackle, and navigation and piloting. Therefore, when the individual units are integrated into a submodule for a given course, scheduling would integrate this skill training thereby reducing overall time necessary to complete the course.

SUBJECT MATTER PRIORITIZATION. The optimum training system would contain modules covering the 11 learning areas identified previously plus a practice module. Because of time and resource constraints, emphasis may be required in certain areas to the detriment of others. In a less than optimum system it is necessary to identify those learning areas which must not be allowed to be degraded. Therefore, a system of priorities was developed which will permit the developers of the three courses to place emphasis where it is most needed.

The criteria for module prioritization were based on four factors derived in section II (page 17). A numerical point system was developed from discussions held with interviewees. These priority factors are defined below:

- Priority factor 1 consists of those elements identified by over 50 percent of the respondents. A numerical value of 1 was assigned each of these elements. One additional point was added for each 10 percentage point interval over the base of 50 percent. Maximum point value for this factor is 6.

- Priority factor 2 consists of those elements which require grading on a "go, no-go" basis. Each of these elements was assigned a point value of 4.

- Priority factor 3 consists of those elements identified by all senior officer ship handlers now engaged in instructional duties. A point value of 3 was assigned each of these elements.

- Priority factor 4 consists of those elements which should be directly reinforced in a synthetic setting. Two points were assigned each of these elements.

Table 8 is a matrix depicting the Prioritization of Learning Modules. A maximum of 15 points is possible for any given module. Seven of the twelve modules received a score of seven or better, and these modules are considered to be the absolute minimum to be included in a ship handling training system. Each of those modules which received a score of 7 or better is best taught in the shore environment.

TABLE 8. PRIORITIZATION OF LEARNING MODULES

Learning Module	Priority Factor					
	1	2	3	4	Total	Priority*
Rules of the Road	6	4	0	2	12	1
Relative Motion	5	4	0	2	11	2-3
Practice	6	0	3	2	11	2-3
Navigation & Piloting	0	4	3	2	9	4
External & Internal Ship Forces	6	0	0	2	8	5
Ground Tackle	2	0	3	2	7	6-7
Own & Other Ship Characteristics	4	0	3	0	7	6-7
Tactical Pubs. & Thumb Rules	2	0	0	2	4	8-10
Meteorology & Oceanography	4	0	0	0	4	8-10
Plan Ahead	4	0	0	0	4	8-10
Own Ship Team	2	0	0	0	2	11
Trainer	0	0	0	0	0	12

* Priority precedence is based on total numerical value. The higher the value the higher the priority.

Unless a given learning module is covered completely, it should not be included in the curriculum at any level of schooling. No attempt should be made to include a module simply to introduce the subject, particularly if this is done at the expense of a higher priority subject. The modules not considered essential to be included in the ship handling training system ashore are those which can be omitted with the least negative effects.

Five learning modules have been specified as not absolutely essential to a shore based ship handling training system. These modules are tactical publications and thumb rules, meteorology and oceanography, plan ahead, own ship team, and trainer. This does not imply that they are not need-to-know, rather, there are other methods of imparting the knowledge required. It would be more efficacious to include these modules in the shore based training system where the relationship to other elements of ship handling could be shown; however, this knowledge can be imparted by any of the individual or combination of the following methods.

- Correspondence courses issued by CNET with the results incorporated in the PQS for OOD's. These courses would be supplemented in the PQS by a series of practical required exercises which insure the trainee demonstrate that the required knowledge had been assimilated and was understood.

- A self-paced course of instruction given to each graduate to be completed within a specified period of time. Completion would require the senior watch officer of that graduate's next seagoing command to verify a series of practical demonstrations of the student's knowledge of the material. Knowledge demonstrations of the material contained in these courses would be incorporated in the PQS for OOD's.

- A series of required courses conducted by the FTC's for JO's who have not been certified.

- Use of on-the-job training. A service record or PQS entry would be made after a satisfactory demonstration that the material had been learned and was completed.

COURSE CONSTRUCTION

BASIC SHIP HANDLING TRAINING. Basic ship handling training for JO's is two phased--OCS, NROTC, or USNA entry level training plus the Basic Course. This discussion of basic ship handling training, the sum of the first submodule of each of the 12 modules, includes the totality of training required to be received at both the accession school and the follow-on school. No attempt has been made to differentiate between

locations in terms of where the training is made available.

The existing SWOS Basic Courses are designed as a follow-on to OCS. Therefore, the SWOS Basic Course entry requirements are based on the OCS graduation requirements. These entry requirements should be reviewed in light of current plans to decrement the OCS from 19 to 16 weeks, which is considered the worst case. Consideration should be given to the availability of existing resources, particularly time, which are severe constraints to the Basic Courses. To insure uniformity throughout the Navy, the ship handling portion of all accession programs should be isolated, and the graduation requirements of all programs based on the minimum graduation requirements of OCS.

The findings of this study (refer to section II) indicate that the Basic Ship Handling Course should accept only those students who have the appropriate personal characteristics. During the course they will be exposed to the required knowledge elements in a classroom setting. Skill training will be added to the classroom training for those knowledge elements which require reinforcement in a synthetic environment. The Basic Course is designed to produce an apprentice ship handler who will, when exposed to appropriate on-the-job experience, develop into a person who can be certified by his CO as a qualified OOD. The existing PQS forms a base from which the course can be developed. Figure 7 illustrates the proposed Basic Course flow for officer accessions.

PERSONAL CHARACTERISTICS. The use of personal characteristics in the selection of officers for the proposed training system depends upon several considerations. First, the economic and pragmatic feasibility of such a selection program must be determined. Second, the personal characteristics must be defined more precisely and means of assessing them identified or developed. Third, it must be empirically demonstrated that there is a direct relationship between these characteristics and the probability of being certified as an OOD(F). Fourth, training system entry levels must be established for each characteristic. Finally, the implications of a specialization placement program for officers who do not meet entry requirements must be carefully investigated. Officers who do not meet the entry requirements will not be eligible to command a combatant ship.

Given, that these requirements can be met satisfactorily, it is recommended that candidates for the proposed training system be selected on the basis of the possession of appropriate levels of the following characteristics:

- Confidence
- Concentration
- Patience
- Positive Attitude
- Fast Reaction

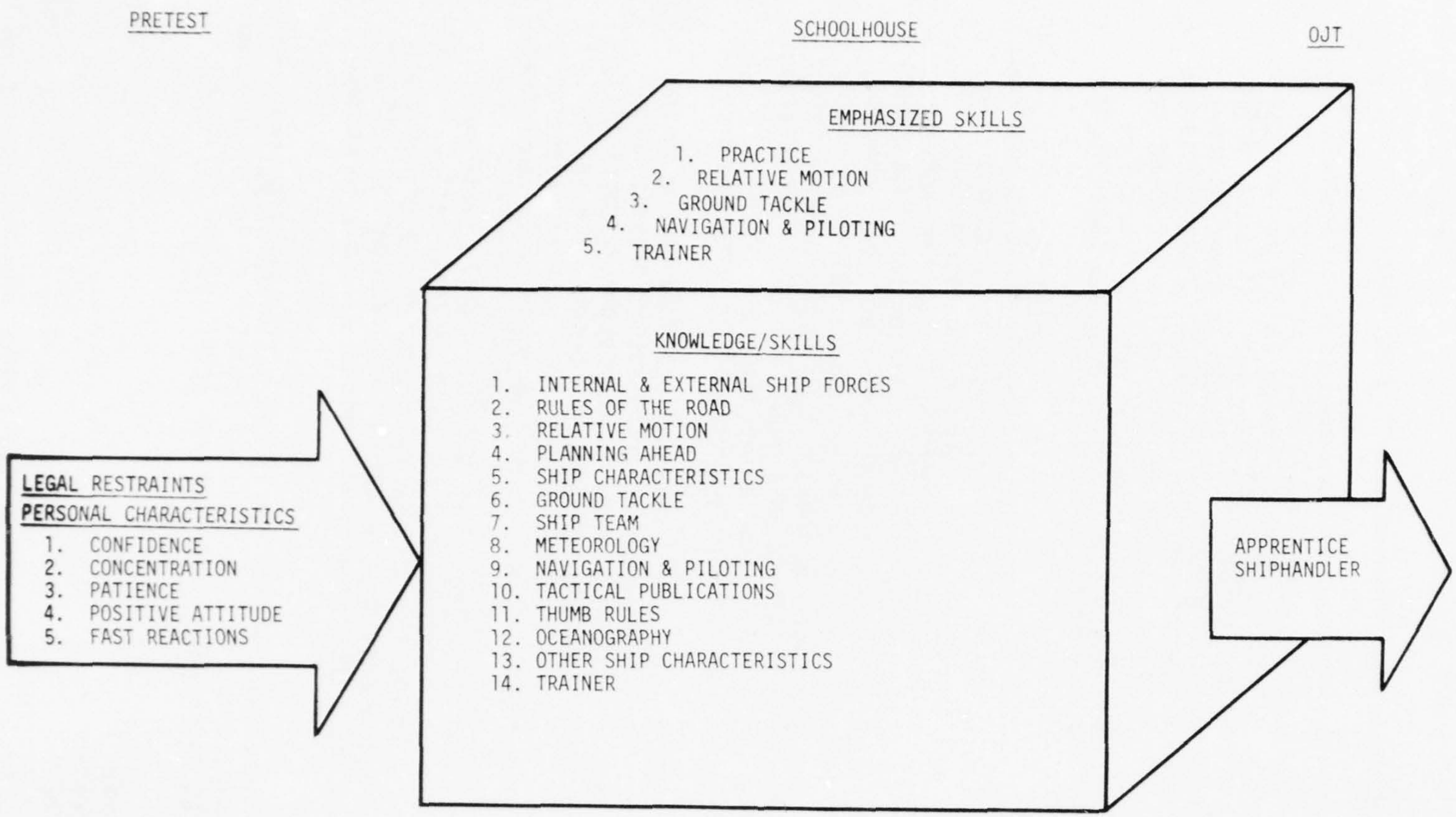


Figure 7. Basic Ship Handling Course Flow

BASIC COURSE LEARNING OBJECTIVES. The learning objectives discussed below are proposed as guides to the Basic Course developer. More detailed objectives will have to be established for the learning unit and bit which detail their content and measurement criteria. Since the objectives are general in nature, and the degree of mastery is frequently based on instructor opinion, only general criteria are given for the submodule learning objectives.

Terminal Objective. The student officer will demonstrate that he has acquired the necessary basic knowledge and basic skills on a small craft or in a simulator needed to assist a qualified conning officer in the operation of a ship in all routine situations.

Enabling Objectives.

The student officer will:

1. When performing on the ship handling team, use correct terminology at all times.

2. When performing as conning officer, demonstrate a detailed knowledge of the procedures to be followed when performing the following evolutions: (a) getting underway, (b) coming alongside a dock or pier, (c) anchoring, (d) steaming in formation, and (e) entering and leaving a harbor.

3. When performing as OOD, JOOW, Signal Officer, or CIC watch officer (CICWO), select the appropriate tactical publication(s) required for the situation at hand.

4. When performing as navigator or CICWO, use the proper navigational tools and publications to fix the position of the small craft or simulator.

5. Demonstrate a knowledge of the proper procedures for maintaining the ship's log, without error, by writing a sample entry and choosing the correct symbols for environmental entries.

6. Under actual or simulated operating conditions, calculate and provide correct maneuvering board solutions to tactical problems.

7. Demonstrate a knowledge of the standard types of ground tackle by describing either orally or in writing the use of anchors, lines, tugs, and pilots.

8. Demonstrate a knowledge, orally or in writing, of all ship handling team stations and the general functions performed at each station.

DEPARTMENT HEAD COURSE LEARNING OBJECTIVES. The following learning objectives are proposed as guidelines for the course developer.

Terminal Objective. The graduate of the Department Head Course of instruction will possess a detailed knowledge of all aspects of ship handling, and will have demonstrated the requisite skills necessary to con a vessel using either a simulator or a small craft in the following minimum situations: (1) mooring, (2) anchoring, (3) emergency procedures, (4) formation and change of formation steaming, and (5) going alongside another underway vessel.

Enabling Objectives.

The student officer will:

1. Demonstrate, either orally or in writing, a detailed knowledge of the rules of the road as they apply in inland and international waters with no more than 2 percent error.

2. Using a simulator, demonstrate a practical knowledge of the application of the rules governing the maneuvering of vessels and the ability to recognize the aspect of other vessels under ideal as well as conditions of reduced visibility.

3. As OOD in a simulator or on a small craft, plan and perform the following evolutions: (a) mooring, (b) getting underway, (c) anchoring, (d) emergency procedures, (e) formation and change of formation, and (f) going alongside another underway vessel.

4. Demonstrate a knowledge of the contents of the tactical publications required by the ship handling team by passing a written, open book examination on the subject.

5. Perform a day's work in navigation.

6. Use the correct navigational publications and charts to plan and lay out the approach to and entry into a foreign port.

7. Elucidate in writing the procedures to be followed in preparing for and reducing the risk of damage to his vessel in heavy weather or storm.

8. During periods of electronic silence when performing as OOD in a simulator or small craft, direct the performance of the ship handling team in a congested harbor, a twisting channel with other ships present, and in the open sea in the presence of other ships.

9. Demonstrate in writing and in a simulator or on a small craft a knowledge of the use of all ground tackle including a stern anchor and the use of an anchor in lieu of or in addition to a tug. The use of tugs will be with and without a pilot embarked.

10. Prepare a training plan for the ship handling team of the class of vessel to which he is ordered.

PCO/PXO COURSE LEARNING OBJECTIVES. The learning objectives given in the subsequent paragraphs relate to the PXO requirements. Since this course applies to the PCO only as refresher training, it is not necessary to discuss its application to the PCO in detail. Reference will be made to that application later in this section. When the officer is assigned to the PCO/PXO Course, he is presumed to have acquired the knowledge and skills required of a competent single-ship ship handler. In addition to refining these skills, this course will cover the supervisory, training, and planning phases which can reduce the incidents of ships becoming in-extremis or involved in dangerous situations. The constraints specified for the learning objectives in the Basic Course are applicable to the learning objectives for the PCO/PXO Course.

Officers in the advanced category would be ordered to the PCO/PXO Course, but would not be required to attend all classes. A pretest would be used to determine which knowledge elements require classroom reinforcement. Skill or practice sessions in either a simulator or a small craft would be mandatory.

Terminal Objectives.

The graduate of the PCO/PXO course will:

1. Have demonstrated, in a simulator or on a small craft, the capability of conning a single and multiple screw vessel in all types of single ship evolutions, and of supervising an underway watch as command duty officer.

2. Have demonstrated in practical exercises the capability to plan and supervise single and multiple ship evolutions in congested waterways during which no vessel is placed in an in-extremis or dangerous situation.

3. Have designed, and orally explained, the execution of a training plan for ship handlers using the class of vessel to which ordered as a basis.

Enabling Objectives.

The student officer will:

1. Have demonstrated orally or in writing and on a simulator with no more than 2 percent error the rules of the road as they apply in Inland and International waters, and a knowledge orally or in writing of the rules as they apply to the Western Rivers and Great Lakes in meeting, passing, and overtaking situations.

2. Name and give a summary of the information contained in all navigational publications required to be used when entering unfamiliar waters or harbors.

3. Demonstrate in writing a knowledge of the operating characteristics of all U.S. Navy capital ships and of the major cargo ships, tankers, and freighters of the merchant fleet.

4. Demonstrate in a series of exercises the ability to maneuver a group of ships in congested waters without exposing the formation, or any ship in the formation, to an in-extremis or dangerous situation.

TRANSITION TRAINING. The purpose of transition training is to provide the officer with explicit knowledge and skills required to perform his ship handling duties aboard a ship with which he has had no recent experience. As such, it would be designed for administration by the FTC's. Transition training should require not more than 1 day in the classroom and 2 days in a simulator or on a small craft.

REFRESHER TRAINING. There are two types of refresher training, that provided to officers in the intermediate category and that provided to the advanced category of officer. Intermediate category officers should have completed the Department Head Course prior to returning to sea duty for the second time. It is presumed that these officers have not been exposed to the conning situation in a responsible position during the shore tour. They can be considered to be below the required level of proficiency in some areas; therefore, this training would be designed to raise their competence level in these areas. There is no need to expend resources to train in areas where these officers' capabilities are equal to, or above, a predetermined minimum level. For this reason, a refresher course should be designed to fill the knowledge and skill gaps rather than to present a fixed curriculum. Officers proceeding to refresher training should be given a pretest prior to commencing the schooling on each of the 11 learning modules in order that areas of weakness can be identified. Appropriate instructional bits can be extracted from each applicable learning module, and individual officers would proceed on a self-paced basis to complete the required study. The Practice Module would be required of all officers attending refresher

training. Practice could be conducted either in a simulator or on a small craft. In the interest of economy, refresher courses should be co-located with the Department Head Course or the PCO/PXO Course.

AIDS AND DEVICES

Existing ship handling aids and devices discussed in subsequent paragraphs are satisfactory for some phases of training. However, their utility must be examined with reference to the required knowledge and skills and the incidence of accidents to determine when and where they best fit into the total system.

DEVICE 1DA5. This device consists of a group of radio controlled scale model ships. It is designed to teach terminology and, primarily, to reinforce classroom knowledge elements in the area of ship characteristics. It could also be used to enhance patience. Used in these ways, it is a part-task trainer and performs the job adequately.

DEVICE 20A61/20A62 AND EMERGENCY SHIP HANDLING TRAINERS. These simulators are a combination CIC/Bridge mock-up which belong to a class of part-task training devices designed to reinforce the use of electronic aids and reinforce the understanding of relative motion. They perform a group of necessary training functions which include, but are not limited to, relative motion, team coordination, the use of electronic devices, and rules of the road under low visibility conditions or at night. When used in a training system, these simulators are outstanding as transitional trainers for JO's in making the change from classroom to an operational unit, and good to excellent for intermediate category officers undergoing refresher training.

SIT-IN MODELS. These models can provide some refresher or transition training for senior ship handlers provided model limitations are clearly understood, and provided the operator adheres to the normal ship delays in responding to helm and engine order commands. Because of the scaling problems discussed in section IV, pages 61-62, there is danger of inappropriate or incorrect training in that the confidence level of the conning officer could be unjustifiably raised.

The sit-in models could serve as a transition training device between the 20A61/20A62 or Emergency Ship Handling Trainer type simulator and the proposed simulator or small craft. These models, unless carefully used and supervised, could be more of a morale booster than a practical training device.

SAILBOATS. The most effective way of learning about the external forces of wind and current is in a sailboat. However, the resources, particularly time, necessary to prepare an officer to sail during any of the three

required courses are considered to be excessive when compared with the value expected to be received.

A sailing course made available to JO's in the Fleet as a part of FTC training could be of value. A great deal of command attention would be necessary to insure that the boats are properly used by the persons for whom the training is intended. In addition, CO's of operational units would have to make time available for the JO's to use the boats, or would have to insure that their JO's actually sailed during their nonduty hours.

PROPOSED DEVICES. Four new devices are proposed. Two of these, a rules of the road and a ground tackle training device, are part-task trainers; the other two, a bridge simulator and new small craft, are system trainers. A functional description of each recommended device is contained in appendix I.

1. Rules of the road are required to be memorized and tested in the classroom. However, the application of the rules, in particular the recognition of situations, and other vessel aspect and lights, requires some additional reinforcement. The proposed device should be designed as a portable unit which could be used in a classroom or in an auditorium. Its purpose would be to insure that trainees recognize situations and can respond with an appropriate solution to the problem situation.

2. Ground Tackle, as used in this study, includes anchors, lines, tugs, and pilots. It is not economically feasible, in the basic course, to skill train in the use of ground tackle in operational craft or on the small craft trainer. In the intermediate courses, it is not economically feasible to conduct all evolutions with which a conning officer is required to be familiar on the small craft trainer. This trainer would serve all required ship handling courses.

The Ground Tackle Trainer would be designed to have the capability of demonstrating the location of ground tackle; the use of ground tackle in making various types of moors to include a Mediterranean moor, flying moors, and moors to a buoy; the makeup of tugs; chain use and markings; nomenclature and terminology; anchoring; and the use of an anchor to retract from the beach.

3. The transition from the classroom or existing simulators to an operational setting can be traumatic, particularly to the inexperienced JO. For safety and cost reasons intermediate and senior categories of officers cannot experience many of the environments or casualties which occur in an operational situation. There is no existing simulator capable of providing transition training between vessels of widely divergent characteristics.

The proposed training system is designed to move in steps from the classroom to part-task trainers to full scale system simulators and finally to operational craft. There is a need to develop a simulator which will fulfill the requirements for transition training and, at the same time, provide for a smooth, step-by-step capability enhancement for Naval officers.

A ship handling training simulator is proposed which meets the following criteria:

. Two bridges designed and fitted out to resemble operational ships' bridges. They need not be class specific, but must contain as a minimum all equipment found on a cruiser (CG) bridge.

. A visual presentation covering at least 270° rotatable through 90° to left or right.

. The capability of visually simulating the open sea, harbor approaches, in a channel, a harbor, and restricted passages. Landmarks and aids to navigation must be available both visually and electronically.

. Simulated electronic capabilities for radar, fathometer, HF/DF, and UHF/VHF radio.

. A minimum of four simulated other ships which can be independently controlled.

. Ability to vary own ship performance characteristics to suit the needs of the training situation.

. External effects of the environment on own ship. These effects must be independently variable. The effects are to include wind, current, sea, bottom effect, and bank effect as the minimum.

. The ability to vary visibility from full daylight to night with such visibility impairments as fog, precipitation, etc.

4. There is no substitute for conning from an actual bridge with a ship and team responding to the conning officer's orders. Therefore, a small craft is necessary to teach the actual interaction between forces, the teamwork necessary, and to give a "feel" to the ship handler. At the present time YP's and utility boats are used. These craft should be retained for that purpose; however, when additional or replacement craft are needed, a new training device which consists of a class of small craft should be considered.

Existing craft are twin screw and highly maneuverable. They cannot, in ship handling situations, be operated as single screw vessels. The

YP's are designed to operate under conditions not applicable to ship handling training in that they are over-designed for the job and very expensive. The utility boats are modified River Mine Sweepers and are cramped in the flying bridge/signal bridge area. Neither craft is designed to absorb the punishment JO's would inflict if they were permitted to make the anticipated judgmental errors when learning to ship handle.

The proposed new class of small craft would have the capability of being operated as either a single or twin screw vessel. The signal and flying bridges would be distinct, and space would be available for observers. Conning support from CIC would be available and equipment and independent space provided for training in the art of piloting for personnel other than the actual ship handling team. Logistical space would be minimal.

TRAINING DEVICE APPLICATION. Prior sections of this report have proposed 12 learning modules and discussed existing and proposed training devices. This subsection unites previous findings by specifying which device (existing or proposed) is applicable to each learning module. Device application is determined by the level or category of the officer student and his qualifications. Table 9 classifies existing and proposed training devices as a function of learning module.

All training devices enumerated in table 9 are not of equal importance and are, therefore, classified in terms of their criticality to the system.

- Required devices are those which are necessary for a complete understanding of the theory and use of the knowledge presented.

- Desirable devices are those which would facilitate learning, but an acceptable comprehension could be acquired without resort to a device. However, without the device additional school house time will probably be required.

- Nice-to-have devices are those which would enhance the learning process, but are unnecessary.

TABLE 9. SHIP HANDLING TRAINING DEVICE APPLICATION

LEARNING MODULES	APPLICABLE TRAINING DEVICES			
	BASIC CATEGORY OFFICER		INTERMEDIATE CATEGORY OFFICER	
	DEVICE[1]	REQUIREMENT CLASSIFICATION	DEVICE[1]	REQUIREMENT CLASSIFICATION
Rules of the Road	a. Film	Required	a. Rules of Road Trainer	Required
	*b. Rules of Road Trainer	Required	b. Small Craft	Required
	*c. Simulator	Desirable	*c. Simulator	Desirable
Relative Motion	a. Audio Visual	Required	a. 20A61/20A62	Required
	b. 20A61/20A62	Required	b. Small Craft	Required
	c. Small Craft	Required	c. Sit-in Model	Desirable
	*d. Simulator	Desirable	d. Sailboat	Nice-to-Have
	e. Sailboat	Nice-to-Have		
Navigation & Piloting	a. Audio Visual	Required	a. 20A61/20A62	Required
	b. 20A61/20A62	Required	b. Small Craft	Required
	c. Small Craft	Required	*c. Simulator	Desirable
External & Internal Ship Forces	a. Audio Visual	Required	a. Small Craft	Required
	b. Small Craft	Required	b. Sit-in Model	Nice-to-Have
	c. Sailboat	Nice-to-Have	c. Sailboat	Nice-to-Have
Ground Tackle	a. Audio Visual	Required	*a. Ground Tackle Trainer	Required
	*b. Ground Tackle Trainer	Required	b. Small Craft	Required
Own & Other Ship Characteristics	a. Audio Visual	Required	a. 1DA5	Required
	b. 1DA5	Desirable	b. Small Craft	Required
			*c. Simulator	Desirable
Tactical Publications & Thumb Rules	a. 20A61/20A62	Required	a. 20A61/20A62	Required
	b. Small Craft	Required	b. Small Craft	Required
	c. Audio Visual	Desirable	*c. Simulator	Desirable
	d. Simulator	Desirable		

* Proposed

TABLE 9. SHIP HANDLING TRAINING DEVICE APPLICATION (continued)

LEARNING MODULES	APPLICABLE TRAINING DEVICES			
	BASIC CATEGORY OFFICER		INTERMEDIATE CATEGORY OFFICER	
	DEVICE[1]	REQUIREMENT CLASSIFICATION	DEVICE[1]	REQUIREMENT CLASSIFICATION
Meteorology and Oceanography	a. Audio Visual	Required	a. Audio Visual	Desirable
Plan Ahead	a. 20A61/20A62 b. Small Craft *c. Simulator	Required Desirable Desirable	a. 20A61/20A62 b. Small Craft *c. Simulator *d. Ground Tackle Trainer	Required Required Desirable Desirable
Own Ship Team	a. 20A61/20A62 b. Small Craft	Required Desirable	a. Small Craft *b. Simulator	Required Desirable
Trainer	a. None	NA	a. Audio Visual	Desirable
Practice	a. 20A61/20A62 b. Small Craft c. 1DA5 *d. Simulator e. Sailboat	Required Required Desirable Desirable Nice-to-Have	a. 20A61/20A62 b. Small Craft c. 1DA5 *d. Simulator e. Sailboat f. Sit-in Model	Required Required Desirable Desirable Nice-to-Have Nice-to-Have

Note 1: Device 20A61/20A62 includes all existing simulators which are a combination CIC/Bridge mock-up.

* Proposed

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Both general conclusions and conclusions by impact area are presented. The individual impact areas are: selection, junior officers, senior officers, accident causes, existing training, and proposed training.

GENERAL.

1. No officer can be certified as a qualified ship handler at any level ashore. These qualifications require a demonstration of skills in an operational setting. Therefore, only an operational commander can certify.

2. Shore based training should insure that the candidate officer has the requisite personal characteristics, is trained in all required knowledge elements, and has demonstrated the capability to perform in a controlled environment.

3. Certification and recertification of Merchant Marine officers and Naval aviators is an existing practice. No consistent, standard, formal certification and recertification procedure exists for U.S. Navy and U.S. Coast Guard surface line officers.

4. There is no verified record upon which CO's can base a judgment of a newly reporting officer's conning capabilities. Word of mouth and service record entries do not provide information in sufficient detail in the needed experience areas.

5. U.S. Merchant Marine and foreign ship handling training is not as complete as U.S. Navy training. Increased attention is being given by the Merchant Marine to shore based training based on simulators both in the United States and abroad.

SELECTION.

6. There are five basic personal characteristics; e.g., confidence, concentration, patience, positive attitude, and fast reactions, inherent in all competent ship handlers. The presence or absence of these personal characteristics, and the degree to which they are present in prospective Naval officers, may be valid indicators of the person's aptitude for ship handling.

7. Not all people are capable of becoming competent conning officers of combatant craft under all conditions because of either a lack of the necessary personal characteristics or for legal reasons.

These persons should be precluded from succession to command but not excluded from the Navy. The Navy should not expend the resources required to attempt to train and qualify all unrestricted line officers, as presently defined, in the ship handling arts.

JUNIOR OFFICERS.

8. The requirements for ship handlers are similar among Navy and Coast Guard junior officers and Merchant Marine junior deck officers. All seagoing officers under instruction must have identical knowledges and skills. However, depending on the service, the areas of emphasis differ.

9. The Navy has no preselection process for officers entering the ship handling training program. Policy dictates that all unrestricted line officers are required to be certified as qualified OOD(F)'s within 3 years. This policy erroneously presupposes that all unrestricted line officers are capable of becoming qualified ship handlers.

10. The burden of certifying JO's as OOD(F) falls on the ship's CO. It is frequently not possible for him to meet this burden; therefore, a significant number of officers are certified as they leave the command or on criteria other than actual performance for the following reasons:

a. Insufficient underway time

b. Emphasis placed by senior commands on the managerial and technical aspects of being a naval officer thereby relegating the conning arts to secondary importance

c. Senior command pressures on the ships' commanding officers cause them to permit only the most highly qualified officers, or the officer who exhibits the greatest potential as a ship handler from among the complement, to assume the con during most ship handling evolutions. Only a small proportion of the wardroom may actually gain experience in an operational situation.

11. The graduates of accession programs are required to attend the SWOS Basic Course which is designed to produce apprentice ship handlers. However, due to a lack of emphasis in specific knowledge areas, and the failure to provide adequate skill training, graduates of the Basic Course have little to no appreciation of the problems associated with ship handling.

12. The PQS ship handling requirements, which form the base for certification as a qualified OOD(F), are unrealistic in terms of operational commitments and underway training time available. Futhermore, the measurement criteria for PQS are not standard.

SENIOR OFFICERS

13. Seagoing Officers junior to the CO of a ship are certified as qualified OOD(F) by letter. Recertification, for all practical purposes, occurs at each new ship and with each new CO. However, the certification and recertification for prospective CO's immediately prior to their assuming command does not always occur, and a practical demonstration of ship handling skills is not required. Even the Command Qualification Board does not use practical, hands-on testing procedures.

14. There are divergent views with respect to recertification. Senior surface officers with continuous exposure to ship handling situations do not feel it is required. Opposed to them are the senior aviation officers as well as senior unrestricted line officers with relatively little continuous exposure to ship handling situations. Tradition should not be permitted to interfere with a viable training and qualifying system.

15. Two factors reduce the ship handling proficiency of senior officers returning to sea duty after extended periods ashore. First, they have not been recently exposed to ship handling situations which results in a temporary reduction in capability. Second, classes of ships, which may have widely divergent characteristics from those with which the officer was familiar, are constantly entering the inventory.

16. Senior officers with relatively little time and experience as a member of a ship's company are finding difficulties in the training of junior officers in the ship handling arts. No training exists for this aspect of a ship handler.

INCIDENT CAUSES

17. The numbers of Naval collisions and groundings which have occurred since 1973 have not significantly decreased despite the increasing number of aids to the conning officer and the decreasing underway time.

18. In the majority of accidents weather, visibility, wind, and current were not significantly involved. This leads to the conclusion that human factors were the primary cause of accidents.

19. The CO of the Naval ship involved in an accident either had the con or was on the bridge in the majority of accidents. It is apparent that conning officers, other than the CO's normally recognize a dangerous situation and request assistance when needed.

20. The primary causes of accidents were errors of omission rather than commission. By this is meant the failure to take necessary or prudent action in time to avoid the accident, the failure to recognize a situation, or the failure to train the ship handling team adequately.

The special sea or maneuvering detail was set in over 50 percent of the accidents. Since the most experienced personnel were in charge at the time the majority of accidents occurred, it is concluded that either an unfamiliarity with basic knowledge elements or the inability to apply these elements is the primary cause.

21. When both the primary and secondary causes of accidents are considered, only nine factors can be considered as contributory to the majority of Naval accidents. These factors are:

(a) Failure to grasp the situation
(b) Overreliance on a pilot
(c) Improper use of ground tackle
(d) Communications breakdown
(e) Failure to follow established doctrine (including rules of the road)
(f) Failure to compensate for external forces
(g) Inadequate use of navigational aids
(h) Lack of command leadership (including training)
(i) Failure to take adequate fixes.

22. Wake damage is the result of a conning officer not realizing the power and cause of a wake; i.e., not grasping the situation and not following prescribed doctrine. No special training is required in this area since the training proposed in this report in the identified knowledge elements should make conning officers aware of this danger.

EXISTING TRAINING.

23. Ship handling has been traditionally treated qualitatively in that the knowledge and skill elements which are required to be possessed by a qualified ship handler have not been precisely defined. Existing ship handling training is based on tradition and individual instructor experience. There is a marked lack of skill training and very little time devoted to the interrelationship of the factors which must be considered in avoiding in-extremis situations.

24. Conning a Naval vessel is only one task of an OOD. Ship handling is a vital subelement of conning. Existing courses do not emphasize conning and ship handling.

25. Poor instruction techniques used with the radio controlled ship models (Device 1DA5) result in trainees learning the trick of maneuvering the models without learning the principles involved.

26. Sailboats can be used to teach relative motion and external forces. They are not considered cost effective if used solely in conjunction with existing shore based training.

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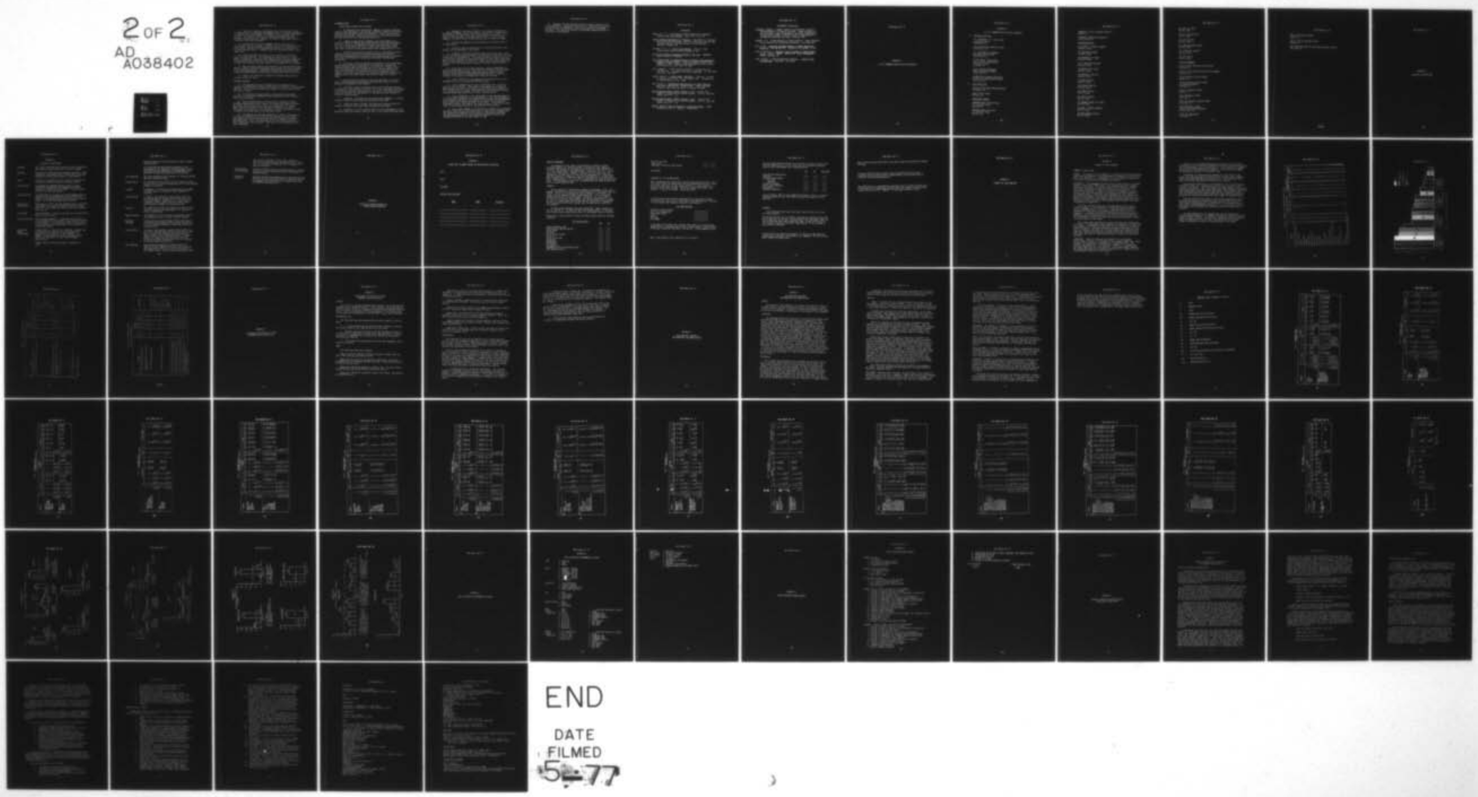

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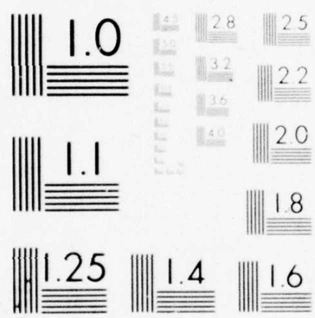

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27. The sit-in models on Lake Chubb cannot be justified in terms of value return for investment, maintenance costs, or resource expenditure. In addition, only small numbers of students can use the device per unit of time. This type of training can be conducted using other, more effective training devices. However, the value of these models may be justified on the basis of morale.

28. Neither the YP's used at Newport, Rhode Island, nor the utility boats used at Coronado, California, for skill training are fully satisfactory. Neither craft was designed primarily as a vehicle for training conning officers. Students do not derive maximum benefit from these craft.

29. Ships dedicated exclusively to ship handling training are a highly desirable feature. This technique, as used by the U.S. Coast Guard, is effective. Because of the numbers of Navy officers undergoing ship handling training, and the cost of maintaining an adequate number of dedicated training ships, this concept is not economical for the Navy.

30. Most existing training aids and devices can be used effectively. However, present utilization techniques do not always take full advantage of the available potential. Additional training aids are necessary to improve the effectiveness and efficiency of Navy ship handling training.

31. There is no transition or effective refresher ship handling training in the U.S. Navy.

PROPOSED TRAINING.

32. The knowledge and skill elements which are required to be learned by a qualified ship handler do not vary with the level of proficiency attained. Only the depth to which each element is studied, and planning proficiency, differ.

33. The retention of many elements of ship handling knowledge training is significantly improved by the integration of skill training into a training system.

34. Officers going directly from one ship to another of widely divergent characteristics must rely on self-study and on Naval officers, not always fully qualified to instruct, for preparation for the new duty. Since many factors affect the time, information, and people available, this situation is not satisfactory. Formal transition training is needed for selected senior ship handling officers.

35. Intermediate and advanced categories of officers proceeding to sea after an extended period in billets far removed from the conning environment require that the knowledge and skill elements be brought to peak efficiency. This is particularly true if the officers have had only limited prior ship crew duty. Some form of formal refresher training is necessary.

RECOMMENDATIONS

CNET should consider the following:

1. In cooperation with operational commands, establish a working group to study the means of instituting a standard, formal certification procedure for prospective Naval ship handlers. Initial certification would be based on PQS. Advanced certification or recertification would be based on written tests and demonstrated skills.

2. Propose to operational commanders the establishment of an Officer of the Deck Underway Watch Qualification Log to be the property of the U.S. Navy, but in permanent custody of the individual officer. This log is to be maintained by all unrestricted line officers from their date of entry into the commissioned ranks through the rank of O-6.

3. Establish and maintain contact with U.S. and foreign training agencies who are involved in ship handling research and training. Establish a permanent working group to insure advances made in simulator and training techniques are incorporated into Navy training where appropriate.

4. Institute a study to determine the feasibility of establishing the aptitude of officer accessions for ship handling. Appropriate testing procedures may be developed as a result of this study. These tests and legal tests should be applied to all officer accessions to assess their potential for becoming qualified ship handlers and for command. Those who do not possess the necessary potential should not be commissioned in the unrestricted line officers' corps as it exists today.

5. Revise the basic courses so that ship handling is a distinct unit. Develop testing criteria based on operational needs to insure graduates are apprentice ship handlers.

6. Institute a study to determine which ship handling evolutions are feasible to be required by the PQS. Revise the performance requirements of the PQS to conform to the results of this study. Ship handling evolutions not practical for incorporation in the PQS should be included in the skill training ashore.

7. Establish, in conjunction with operational commanders, a minimum standard criteria for PQS completion applicable Fleet wide.

8. Establish formal refresher ship handling training courses for officers returning to sea duty after extended periods ashore.

9. Establish a unit of training devoted to the development of an on board ship handling training system for JO's in the required PCO/PXO Course.

10. Reemphasize the need to report all accidents, regardless of the degree of damage, and all near misses, and maintain a record of all environmental and human factors which contributed to incidents. On a regular, recurring basis make these data available to the training community so that existing training courses can be revised as needed.

11. Increase the emphasis on ship handling as a distinct unit in all OOD courses.

12. Propose to CNO the acceptance of a viable definition of ship handler such as developed in this study.

13. Implement three required shore based schooling periods. One will be for the new accession and will be designed to raise his proficiency to the level of an apprentice. The second and third courses will be for qualified ship handlers and should be designed to raise their proficiency level to that required of a ship's CO. These required courses should be the basis for a training system structured to cover a Naval officer's career.

14. Direct the Chief of Naval Technical Training (CNTECHTRA) to develop and implement a career structured ship handling training system based on three required ashore schooling periods. Formal optional training courses should be developed and made available to selected officers in the areas of refresher and transition training.

15. Direct CNTECHTRA to investigate the practicability of using sailboats at FTC's in conjunction with OOD courses.

16. Direct CNTECHTRA not to acquire additional YP's or utility boats for skill training. Additional or replacement craft should be modeled after the small craft training device discussed in appendix I. It is proposed that a concept formulation study be initiated to develop detailed design specifications for such a training device.

17. Direct CNTECHTRA, in the development of the required courses, to insure course developers give consideration to both the knowledge and skill elements required of ship handlers and the human and environmental factors which most frequently appear in accidents. Care should be exercised to insure that each of the three courses is restricted to that level of proficiency required of the graduate of that course.

18. Direct CNET SUPPORT to initiate the procurement of the proposed devices at the earliest practicable date so they can be integrated into the proposed ship handling training system as they become available. The new devices proposed in this study are required to insure high knowledge retention in the least amount of time.

19. Implement the ship handling training concept proposed in this study immediately. Supportive studies can be conducted simultaneously and the results incorporated in the revised system as they become available. This will give impetus to the needed command attention in the area of ship handling.

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APPENDIX A

LIST OF COMMANDS AND ACTIVITIES CONTACTED

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LIST OF COMMANDS AND ACTIVITIES CONTACTED

A. <u>Non-Navy Activities</u>

Hq, Commandant, U.S. Coast Guard
Licensing Section
Washington, DC

National Maritime Research Center
Kings Point, NY

U.S. Department of Commerce
Maritime Administration
Washington, DC

Flight Safety Incorporated
Marine Safety International
LaGuardia Airport
Flushing, NY

Sperry Systems Management
Marine Technology Systems
Great Neck, NY

Grumman Data Systems Corporation
National Maritime Research Center
Great Neck, NY

B. <u>Navy Activities</u>

Office of the Judge Advocate General
Washington, DC

Naval Safety Center
Norfolk, VA

<u>Operational Staffs</u>

Commander Naval Surface Force
U.S. Atlantic Fleet
Norfolk, VA

Commander Naval Air Force
U.S. Atlantic Fleet
Norfolk, VA

Commander, Cruiser Destroyer Group 12
Mayport, FL

Commander, Amphibious Squadron 6
Little Creek, VA

Operational Units

USS CLAUDE V. RICKETTS (DDG-5)
Atlantic Fleet

USS BASILONE (DD-824)
Atlantic Fleet

USS AINSWORTH (FF-1090)
Atlantic Fleet

USS FT SNELLING (LSD-30)
Atlantic Fleet

USS BOULDER (LST-1190)
Atlantic Fleet

USS NASHVILLE (LPD-13)
Atlantic Fleet

USS AUSTIN (LPD-4)
Atlantic Fleet

USS TRUCKEE (AO-147)
Atlantic Fleet

USS ALAMO (LSD-33)
Pacific Fleet

USS DULUTH (LPD-6)
Pacific Fleet

USS BARBOUR COUNTY (LST-1195)
Pacific Fleet

USS JOHN S. MCCAIN (DDG-36)
Pacific Fleet

USS NEW ORLEANS (LPH-11)
Pacific Fleet

USS GRAY (FF-1054)
Pacific Fleet

USS ST LOUIS (LKA-116)
Pacific Fleet

USS CREE (ATF-84)
Pacific Fleet

USS CONSTELLATION (CV-64)
Pacific Fleet

USS TURNER JOY (DD-951)
Pacific Fleet

USS FOX (CG-33)
Pacific Fleet

Training Commands

Chief of Naval Education and Training
Pensacola, FL

Chief of Naval Education and Training Support
Pensacola, FL

Surface Warfare Officers School
Newport, RI

Surface Warfare Officers School
San Diego Detachment
Coronado, CA

Officers Candidate School
Newport, RI

Naval Amphibious School
Coronado, CA

Naval Antisubmarine Warfare School
San Diego, CA

Naval Amphibious School
Sea/Shore Training Department
Little Creek, VA

Fleet Training Center
San Diego, CA

Naval Yard Patrol Squadron
Newport, RI

Naval Training Equipment Center
Orlando, FL

Naval Education and Training Support Center, Pacific
San Diego, CA

APPENDIX B

GLOSSARY OF DEFINITIONS

APPENDIX B

GLOSSARY OF DEFINITIONS

Accident	The overall description of a series of events, decisions, and situations which culminate in injury or damage.
Aptitude	The physical characteristics and mental abilities of the prospective ship handler which indicate that he has the capacity to acquire proficiency as a ship handler.
Cause	In terms of an incident, cause is used to identify the direct and secondary reasons an accident occurred.
Certification	A statement by competent authority that a conning officer has demonstrated all knowledge and skills required of a qualified ship handler. A certification is part of an official record.
Conning Officer	The person who is in charge of the ship maneuvering and ground tackle team and who makes the decisions with respect to the maneuvering of the ship and use of ground tackle. He is the environment-team interface.
Elements of a Ship Handler	Those specific skills and the knowledge which a qualified ship handler must become proficient in prior to being certified. It includes the requisite personal characteristics as well.
Environment	The environment is limited to the physical characteristics extant at a given time.
Existing Training	That training, whether in a classroom, on a device, or in an operational setting, which is available at the time of this report. It is defined in terms of lesson plans for a schoolhouse setting and PQS for the operational or on-the-job training.
Expert Ship Handler (Interviewee)	A Naval officer of the rank of Lieutenant or higher who has qualified as a SWO, or who is training other unrestricted line officers in ship handling. An element of this definition is that seagoing officers must be, or have been, at least senior underway watch officer. A Coast Guard officer who has been in command of a ship.

	A Merchant Marine officer who holds at least a second officer rating.
	A civilian who has had extensive exposure to the development of ship handling training systems, or who has had extensive experience in the development and operation of major ship handling training devices.
Fast Reactions	The rapid recognition and response to a stimulus and the ability to perform quickly.
Ground Tackle	Any aid which is used to hold a ship in place, or move, or cause the ship to move through the use of forces applied external to the ship.
Incident	A dangerous or in-extremis situation wherein no damage to either vessel, or personnel injury necessarily occurred.
Junior Officer	In terms of ship handling, junior officer refers to any officer who has not been certified by his CO as a qualified OOD(F). Generally, it is the Ensign and Lieutenant (junior grade) striving to obtain this qualification, although it could be any rank.
Patience	The capability to exert self-control and exhibit calmness while awaiting the development of a situation in trying circumstances.
Recertification	The renewal of a certification at stipulated times or at stipulated points in a Naval officer's career.
Refresher Training	Training given a certified Naval officer upon return to sea duty from extended periods ashore to insure he is in all respects prepared to assume the duties of a conning officer.
Senior Officer	In terms of ship handling, senior officer refers to any officer who has been certified qualified as a SWO and is, or has been, charged with the training of junior officers in the conning situation. A senior officer will generally have filled more than one billet at sea which required him to act in a conning or conning supervisory capacity.
Ship Handling	Those situations wherein the conning officer is required to make immediate decisions with respect to the maneuvering of the ship, and outside aids; i.e., CIC, ground tackle (including tugs), navigational aids,

etc., are of relatively little value. However, a failure to use outside aids, the improper use of these aids, or the lack of preparation for a situation is poor ship handling.

Ship Handling Training System	A career-oriented system of training designed to prepare officers to qualify and maintain their proficiency as conning officers.
Transition Training	Training provided to personnel who are qualfiied conning officers in one or more ship classes to prepare them for the assumption of conning duties in another ship class of different characteristics.

APPENDIX C

GUIDELINES FOLLOWED DURING THE UNSTRUCTURED INTERVIEWS

APPENDIX C

GUIDELINES FOLLOWED DURING THE UNSTRUCTURED INTERVIEWS

UNIT:

DATE:

LOCATION:

PERSONS PARTICIPATING:

NAME	RANK	POSITION

GENERAL BACKGROUND

For purposes of this study, ship handling is defined as those situations wherein the conning officer is required to make immediate decisions with respect to the maneuvering of the ship, and outside aids; i.e., CIC, ground tackle (including tugs), navigation aids, etc., are of relatively little value. However, a failure to use outside aids, the improper use of these aids, or the lack of preparation for a situation is poor ship handling. Frequently, the term ship handling is confused with OOD or master mariner. It is, in fact, a subelement of these two qualifications. The PQS requires an officer to demonstrate ship handling qualities prior to qualification as OOD.

ELEMENTS

We are looking for the specific elements of knowledge, skills, and personal characteristics which go into the making of a fully-qualified ship handler. We are not concerned with the exceptional, rare officer, but rather with the average, minimum qualified person. It is from these elements one builds a training system. Therefore, one major effort in this study is to define these elements and specify exactly what is meant by each. In other words, what do you, who are qualified and responsible for training junior officers, believe goes into making up a qualified ship handler?

To date, 20 odd elements have been identified. These include, but are not limited to: (1) Rules of the road (understanding), (2) External and internal forces affecting the ship, (3) Confidence, and (4) Practice.

Please give us your opinion of these, and those others which you consider necessary.

<u>For Team Use Only</u>

	Yes	No
Forces affecting ship	____	____
Understanding relative motion	____	____
Plans ahead	____	____
Patience	____	____
Use of ground tackle	____	____
Practice	____	____
Rules of the road	____	____
Navigation	____	____
Meteorology	____	____
Confidence	____	____
Concentration	____	____
Knowledge of the ship handling team	____	____
Ship characteristics	____	____

Positive attitude	____	____
Thumb rules	____	____
Knowledge of tactical publications	____	____

DISCUSSION

PROBLEMS OF A JO IN QUALIFYING.

Some respondents have stated they consider ship handling to be an art or skill which cannot be learned but can be improved with practice. This would mean there must be some inborn quality in a person before he begins to learn about conning. Others say anyone can become a ship handler; it can all be taught. How do you feel?

If there need be some personal characteristic a person must possess before they can learn to be a ship handler, what may that be? (Ask only if prior answer says everyone cannot be a ship handler.)

<u>For Team Use Only</u>

Visualize relative motion	____
Ability to concentrate	____
Calm under stress	____
Alert	____
Aptitude	____
Plan ahead	____

It has been said by some that conning a Navy ship is, in reality and pragmatically, a secondary duty to that of Naval officer's other duties. Policy and instruction contradict this belief. Please comment on this.

What is the cause of this condition (if it exists)?

Do all surface warfare officers on all classes of ships (or your ship) have the opportunity to con the ship under the following conditions which are PQS requirements for a conning officer?

	Yes	No	How Often
Entering and leaving port	_____	_____	_____
Anchoring	_____	_____	_____
Underway replenishment			
Vertical	_____	_____	_____
Alongside	_____	_____	_____
Formation steaming	_____	_____	_____
Docking and undocking	_____	_____	_____
Plane guard	_____	_____	_____
Emergency maneuvers	_____	_____	_____

In your opinion, where is the greatest deficiency in JO (i.e., ensigns reporting aboard for the first time) training with respect to ship handling?

ADVANCED.

The following points cover the senior Naval officers up to and including Captains.

We believe that JO's are, in effect, certified as conning officers when the CO signs off on the PQS. We also believe that department heads are recertified when their new CO qualifies them. Do you believe senior ship handlers should be certified? Recertified? If so, by whom, to what criteria, and when?

In qualifying as an OOD (ship handler), is there an established procedure such as PQS which is followed at all commands? Are the criteria equal between and among ships?

Does an officer going from shore to sea duty require ship handling refresher training?

Is moving from ship class to ship class, particularly a low to high freeboard, twin to single screw, a simple matter, or would some form of transition training be appropriate?

What difficulties in ship handling training of JO's do senior officers with a subsurface or air background encounter when they assume a senior surface warfare officer billet or command? Do they need training to train?

APPENDIX D

ELEMENTS OF SHIP HANDLING

APPENDIX D

ELEMENTS OF SHIP HANDLING

SUMMARY OF SURVEY DATA

PURPOSE. The purpose of this summary is to present the detailed findings drawn from the responses of 38 governmental and commercial activities to define the elements; i.e., knowledges, skills, and personal characteristics, that any qualified ship handler must possess.

METHODOLOGY. One fundamental building block in the design of a training system is the explicit definition of all knowledge and skill elements required to be taught. A thorough review of the literature revealed that these factors had not been so defined for a ship handler. To correct this situation, a survey of qualified ship handlers, using an unstructured interview approach, was selected as the most expeditious and reliable means of identifying the knowledge and skill profile of a qualified ship handler. The personal characteristics necessary to be present in all qualified ship handlers were uncovered during this survey. The general format and subject areas addressed during these interviews are presented in appendix C.

Since the training system was to be designed to cover a Naval officer's career, it was necessary to include advanced ship handling training considerations in the survey. Questions asked to elicit information on the need for advanced training are also set forth in appendix C. A summary discussion of the data obtained and statistical procedures used is presented below. The critical survey results and their application to Navy ship handling training are addressed in detail in the main body of this report.

The survey sample population consisted of 34 Navy and 4 commercial activities. This population sample numbered 119 personnel, all qualified ship handlers. Interviews were conducted in small groups of from two to seven individuals. The data recorded during group interviews with each activity represent the concensus of the personnel participating in the interview. When no concensus was reached, no data were recorded unless there were two specific, identifiable opinions in which case both were recorded.

DISCUSSION. Table D-1 presents the elements of a ship handler. Percent sample response is indicated for each element identified. These elements are classified by knowledge/skill, emphasized skill, and personal characteristics. As indicated in table D-1, an element may fall under more than one classification. The percent sample response was used as the basis for a cumulative ranking of all elements and also for precedence ranking by classification.

Figure D-1 is a histogram which graphically depicts the relative importance of the ship handling elements as viewed by the sample population. This histogram should not be interpreted as a prioritization of elements relative to training importance or emphasis. A prioritization scheme was developed in section V of the basic study.

In addition to identifying the elements of a ship handler, the survey also addressed certain training issues from the career viewpoint. These issues were problems encountered by JO's in qualifying and ship handling training requirements for senior Naval officers.

Survey results pertaining to the problems of JO's in qualifying are presented in table D-2. Only Naval activities were included in this portion of the survey. Table D-2 presents the total number of activities responding to each topic and, where applicable, sample response percentages. These percentages are based on the total number of responses to each topic and not on the total sample population. Qualitative responses are presented and ranked according to the total number of responses given.

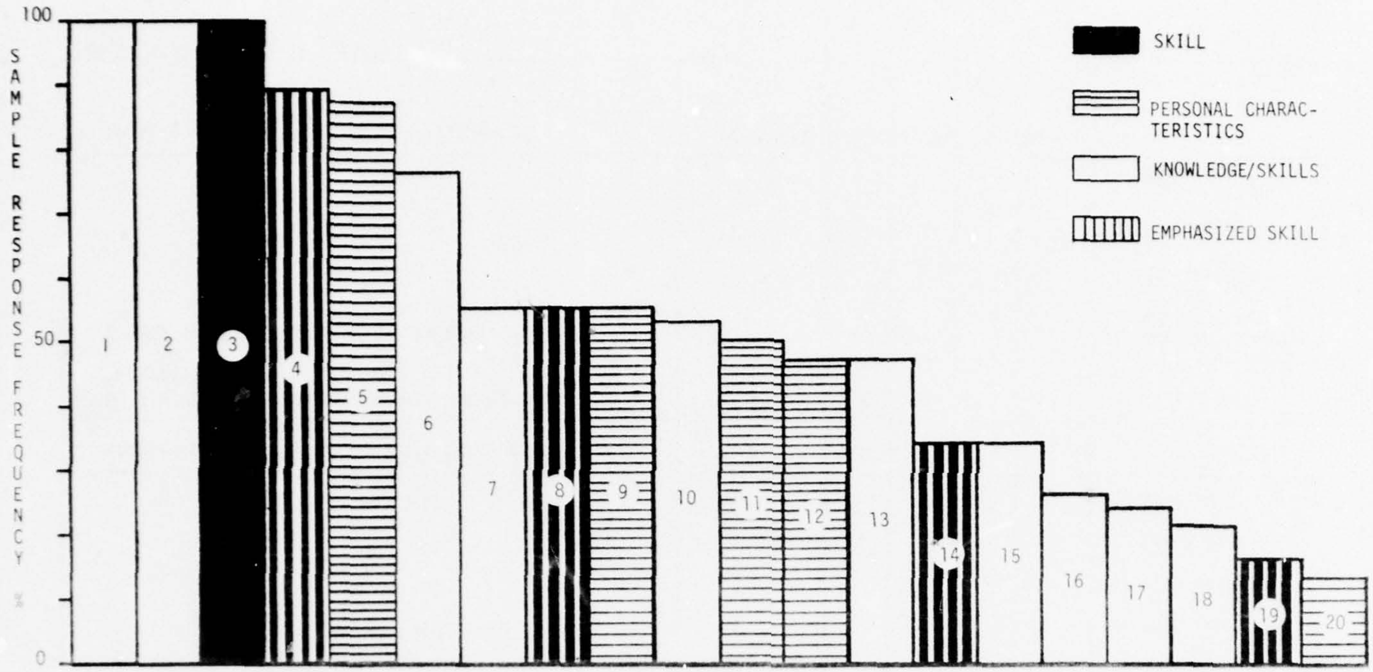
Table D-3 presents the results of the survey pertaining to issues affecting advanced ship handling training for senior Naval officers. The analytical techniques used to develop table D-3 are identical to those used in the development of table D-2; i.e., only Naval activities were sampled and percentages and rankings are based on actual total responses.

The data presented in this appendix was used to identify the learning modules necessary in a career structured ship handling training system for Naval officers. The analytical techniques used, conclusions drawn, and application of this data in the design of the training system are addressed in detail in the main body of this report.

TABLE D-1. ELEMENTS OF SHIP HANDLING OFFICER SURVEY RESULTS

ELEMENTS	NI*	ELEMENT IDENTIFICATION % SAMPLE POPULATION	PRECEDENCE RANKING CUMULATIVE	KNOWLEDGE/ SKILL	EMPHASIZED/ SKILL	PERSONAL CHARACTER-TICS
Internal & External Ship Forces	38	100	1	1	NA	NA
Rules of the Road	38	100	2	2	NA	NA
Practice	38	100	3	NA	1	NA
Relative Motion	34	89	4	3	2	NA
Confidence	33	87	5	NA	NA	1
Planning Ahead	29	76	6	4	NA	NA
Ship Characteristics	21	55	7	5	NA	NA
Ground Tackle	21	55	8	6	3	NA
Concentration	21	55	9	NA	NA	2
Team Knowledge	20	53	10	7	NA	NA
Patience	19	50	11	NA	NA	3
Positive Attitude	18	47	12	NA	NA	4
Meteorology	18	47	13	8	NA	NA
Navigation and Piloting	13	34	14	9	4	NA
Knowledge of Tactical Publications	13	34	15	10	NA	NA
Thumb Rules	10	26	16	11	NA	NA
Oceanography	9	24	17	12	NA	NA
Other Ship Characteristics	8	21	18	13	NA	NA
Trainer	6	16	19	14	5	NA
Fast Reactions	5	13	20	NA	NA	5

Sample Size (34 Naval and 4 Non-Naval Activities)
*NI = Number Commands Identifying Element



1. Internal & External Ship Forces
2. Rules of the Road
3. Practice
4. Relative Motion
5. Confidence
6. Planning Ahead
7. Ship Characteristics
8. Ground Tackle
9. Concentration
10. Team Knowledge
11. Patience
12. Positive Attitude
13. Meteorology
14. Navigation & Piloting
15. Tactical Publications
16. Thumb Rules
17. Oceanography
18. Other Ship Characteristics
19. Trainer
20. Fast Reactions

Figure D-1. Ship Handling Elements (Rank Order of Replies)

TABLE D-2. SHIP HANDLING SURVEY RESULTS

Problems of a Junior Officer in Qualifying

QUESTION	RESPONSE					RANK/RESPONSE
	TOTAL	YES NO.	YES %	NO NO.	NO %	
1. A. Can everyone learn ship handling?	30	5	17	25	83	
B. What characteristics must a ship handler have?	16					1. Visualize relative motion
	16					2. Aptitude
	13					3. Calm under stress
	8					4. Plan ahead
	8					5. Concentration
	5					6. Alert
2. Pragmatically, is conning a secondary duty?	27	24	89	3	11	
3. A. Are PQS conning requirements met by all SWO's in qualifying?	25	4	16	21	84	
B. Why are PQS requirements not met?	19					1. Lack of underway time
	12					2. Too many JO's
	2					3. Personnel turnover
	2					4. Senior Command Pressures
4. What is greatest JO training deficiency?	RESPONSES NOT CONDUCIVE TO ANALYSIS.					

Sample Size: 34 Naval Activities

TABLE D-3. SHIP HANDLING SURVEY RESULTS

Advanced Training Considerations

QUESTION	RESPONSE					RANK/RESPONSE
	TOTAL	YES NO.	YES %	NO NO.	NO %	
1. A. Should ship handlers be certified?	24	17	71	7	29	
B. Should ship handlers be periodically re-certified?	18	15	83	3	17	
C. When? (Certified and Recertified)	4					1. Change of ship
	1					2. Shore/Sea rotation
	1					3. PCO/PXO
D. By Whom? (Certified and Recertified)	9					1. JO's by CO
	8					2. PCO/PXO Board
	2					3. Squadron Commander
2. Are criteria for PQS qualifications standard?	34	0	0	34	100	
3. Do senior officers require refresher training?	27	20	74	7	26	
4. Do senior officers require transition training?	26	25	96	1	4	
5. Are senior sub-surface/air officers trained to train surface warfare officers?	21	9	43	12	57	

Sample size: 34 Naval Activities

APPENDIX E

DISCUSSION OF OFFICER OF THE DECK UNDERWAY QUALIFICATIONS LOG

APPENDIX E

DISCUSSION OF OFFICER OF THE DECK UNDERWAY QUALIFICATIONS LOG

CUSTODY

The Officer of the Deck Underway Qualifications Log was the personal property of the individual officer. It was, however, to be submitted to the individual's CO for his inspection or entry therein whenever requested by him. The log contained the following statement, "This log book may not be used in an investigation or as the basis of any legal proceeding."

RESPONSIBILITIES

The individual had three responsibilities with respect to the log book.

1. To insure legible entries which provide a complete, accurate, and current record of all items called for in the forms.

2. Whenever provisions for the use of the log required extracts or entries by or signatures of persons other than the owner, it was his (the owner's) responsibility to exercise the initiative in obtaining that which was required.

3. The log was to be maintained intact and used completely before obtaining a new one.

FORMS

Ten individual forms were included.

Form 1 listed the OOD qualifications attained, the date, and the ship. Each entry was verified by the CO.

Form 2 was the record of prerequisites completed as the officer proceeded toward his underway OOD qualifications. Again verification of all entries was by the CO.

Form 2A was the annual summary of previous logs. The sum of hours devoted to each conning function was verified by the CO.

Form 3 was a record of evaluations made of the officer, and entered by the officer's CO.

Form 4 was a record of the actual hours on watch as a JOOW or OOD underway. It included space for the type of operations the ship was engaged in. A cumulative total was maintained. Verification was by the Senior Watch Officer.

Form 5 contained a complete record of all moorings and unmoorings, and the type moor performed. Verification was by the Senior Watch Officer.

Form 6 was a verified record of all underway replenishment conning efforts. The Senior Watch Officer signed this form.

Form 7 was a verified record of all man overboard recoveries, whether or not it was a drill, and the method of recovery. Again, the Senior Watch Officer was the verifying authority.

Form 8 recorded the incidents of entry/departure from port during which the log owner was the conning officer. Entries were signed by the Senior Watch Officer.

Form 9 was a Mishap Log. Entries in this form were to be made only by the CO. This form included space for the type of mishap, cost of repairs, and conning errors.

OBSERVATIONS

An inspection of this log provided the CO of a newly reporting officer sufficient information upon which to base a preliminary judgment with respect to that officer's conning experience. Further, since all entries were verified by either the Senior Watch Officer or the CO, the log could be considered to be reliable.

There is now no method in existence for an officer to maintain a verified record of his qualifications and experience. Equally important, there is no way for a CO to estimate the capabilities of newly reporting officers or to assess the capabilities of the officers of his ship when he reports aboard to assume command. A communications void exists which requires some simple, inexpensive measure to close the information loop. An Officer of the Deck Underway Qualifications Log similar to the one issued by COMCRUDESPAC would satisfy the requirement. However, should such a record be reinstated, consideration should be given to:

1. Eliminating Form 3, Evaluation and Remarks. This form was a personal assessment and should not have been passed from one CO to another. It would have been far better, in recertifying an officer, to have had a totally independent assessment. In addition, an evaluation of an officer's capabilities would be better included in his fitness report.

2. Eliminating Form 9, Mishap Log. Incidents are the subject of investigations and a report to the Naval Safety Center. Personal information should not be extracted from these reports and included in a running log. Further, it is considered that this log sheet could influence the judgment of a new CO, which may not be an appropriate approach. See comments under No. 1 above.

3. Removing the statement from the instructions that the log may not be used in an investigation or as the basis of any legal proceeding. Any such log issued by the U.S. Government remains the property of the U.S. Government, but may be given to the individual for custody. It would be appropriate, and necessary, that the log be available for inspection by authorized Naval authorities.

4. Instituting the requirement for the log and instructions covering its maintenance through a Navy-wide directive.

APPENDIX F

SHIP HANDLING ACCIDENTS
ENVIRONMENTAL AND HUMAN FACTORS

APPENDIX F

SHIP HANDLING ACCIDENTS ENVIRONMENTAL AND HUMAN FACTORS

PURPOSE

The purpose of this appendix is to present the detailed findings of a sample taken of 196 Navy and Merchant Marine ship handling accidents to determine the degree of influence of selected environmental and human factors on such accidents. Wake damage is not analyzed in this appendix.

DISCUSSION

The knowledges and skills required of a qualified ship handler were developed from the survey findings discussed in appendix D of this report. These knowledges and skills represent basic building blocks in the development of a ship handling training system; they do not, in themselves, constitute the information necessary to design a complete ship handling training system. Two additional factors influence the design. These factors are the environmental and human factors which influence the ship handler in the performance of his task. An analysis of these factors is crucial to the successful design of a training system, particularly with respect to the identification of deficiencies in existing training and new requirements for training. Each factor includes many complex interrelated variables, therefore, an analysis of ship handling accidents was selected as the most efficient and reliable means of identifying these factors. By establishing a profile of the human and environmental factors that constitute the causal chain which culminates in an accident, and comparing these to the existing training, it is possible to identify probable training deficiencies. Identification of these deficiencies permits training solutions to be developed and incorporated into the design of a career structured training system for Naval officers.

METHODOLOGY

The accident data presented in this appendix was obtained from the files of accident reports obtained from the Naval Safety Center, the Judge Advocate General's Office, and from publications issued by the Chamber of Shipping of the United Kingdom. A total of 550 maritime accidents were reviewed from the standpoint of their relevancy to the ship handling study and the completeness of the data contained therein. Fourteen basic factors were identified, and only those accidents which contained the basic data enumerated in the report were used. Of the total number reviewed, a sample of 196 (126 Navy and 70 Merchant Marine) cases met the established criteria and were selected for in-depth analysis.

Essentially, two separate analyses were performed, one to establish the environmental profile and one to establish the human factor profile. Identical data reduction techniques were used for both analyses.

ANALYSES

Table F-1 presents the data accumulated from the accidents on the environment at the time of each accident. Table F-2 presents the data on the human factors. Symbology associated with the subsequent discussions is given with the tables. (Tables are located at the end of the appendix.)

Accidents were divided into collisions, groundings, and any other type of accident. Wake damage was not subjected to analysis since these reports were always incomplete, and conning officers were not always aware of the damage caused. Wake damage was discussed as a special case in section III of the basic report.

Within the category of collision two major subcategories became apparent and displayed widely divergent causative factors. Data for collisions were collected on the basis of collisions between two underway vessels, tabulated SHIPS in tables F-1 and F-2, and collisions between one underway vessel and a stationary object, tabulated OTHER in the tables. These, added to groundings and other types of accidents, gave four major categories of accident.

Within each category three types of data were of interest: the totals of accidents, those in which Naval units were held to have been the most responsible party, and those in which Merchant Marine units were held to have been the most responsible party. Data were tabulated against each of the 4 categories of accidents by the 14 usable factors identified in appendices G and H. Data for one human factor, Conning Officer Experience, were not available. In addition, it was found that the direction of the current and wind was not material; therefore, these data were not used. Each factor was broken into variables which, by the degree of intensity, would impinge on any training system. For example, time was divided into daylight, dusk, and night, each being descriptive of the amount of ambient light available. Thus the degree each factor might have affected the causal chain leading to an accident could be identified by the variable within the factor.

The relationship between variables was computed in percentages in all cases. This was done because percentages give the most efficient and easily compared results.

COLLISIONS. From the total accidents, the percentage of the variable as applicable to each service is computed. Within each service the percentage of the variable to the total accidents of the service is presented. For example, in table F-1, using the factor TIME, and the variable DAYLIGHT

it can be seen that 75 percent (Ns/Ts) of the two ship collisions (28) were Navy. Within the Navy, 58.3% (%Ta) of the two underway vessel collisions (36) occurred during daylight hours. Using identical rationale, the Navy had 72.4% (No/To) of the single underway vessel collisions (58). Of the 50 Navy single ship collisions 84.0% (%Ta) occurred during daylight.

Since the category, collisions, has two subcategories, a total covering all collisions is presented as well as for the subcategories. These totals delineate the percentage of accidents by variable and service to the total number of accidents. To illustrate, of the total collisions occurring during daylight (86), the Navy had 24.4% (Ns/Tc) which involved two underway ships, and 48.8% (No/Tc) involving single underway vessels. In addition, it is shown that 32.6% (Ts/Tc) of the total accidents occurring during daylight were between two underway vessels. Lastly, of the total number of collisions (134), it can be seen that 64.2% (%Ta) occurred during daylight hours.

GROUNDINGS. The number of groundings is also tabulated by service as well as by the total number. Following the logic of the preceding section, the Navy had 86.2% (Ng/Tg) of the total groundings (29) which occurred during daylight. Of the total Naval groundings (35), 71.4% (%Ta) occurred during daylight hours.

OTHER. All accidents investigated other than collisions and groundings involved Naval vessels only. Since only five were reported, the statistics within this category are not meaningful. However, when the data from these five are included in the totals of all accidents, they do have meaning.

TOTAL ACCIDENTS. The totals included all accidents investigated and are divided by service. Of the total number of accidents (196), 119 occurred during daylight which equates to 60.7% (%Ta). Ninety-two of the total (Tin) were Navy daylight accidents and this equals 73.0% (%Ta) of the total Navy accidents (126).

DISCUSSION. Figures F-1 through F-8 are histograms which summarize the results of the environmental factors presented in table F-1. These histograms represent Navy data only. They establish the environmental profile for Naval ship handling accidents. It can be seen that the majority of the accidents occurred during daylight on either the forenoon or afternoon watch with the special sea detail set under ideal weather conditions.

The human factor profile for Navy ship handling accidents is graphically depicted in figures F-9 through F-14. In the majority of accidents the CO had been on the bridge for better than 15 minutes. The five primary causes in the majority of the accidents were the inadequate use

of the navigation aids, the failure to compensate for external forces acting on the ship, the failure to grasp the situation, a communications breakdown, and a failure to comply with established doctrine. Contributing to, but not directly responsible for, the accidents were the failure to grasp the situation, a communications breakdown, the lack of command leadership, the failure to compensate for external forces acting on the ship, the improper use of ground tackle, and overreliance on the pilot.

SYMBOLOGY USED IN TABLES F-1 and F-2

N	-	Navy
M	-	Merchant Marine
T	-	Total
Ns	-	Number Navy Ship Collisions
Ms	-	Number Merchant Ship Collisions
Ts	-	Ns + Ms
No	-	Number Navy Other Collisions
Mo	-	Number Merchant Ship Other Collisions
To	-	No + Mo
Tc	-	Ts + To
Ng	-	Number Navy Groundings
Mg	-	Number Merchant Ship Groundings
Tg	-	Ng + Mg
Too	-	Total Navy Accidents not Collisions or Grounding
Ti	-	Tc + Tg + Too
Tin	-	Navy Portion of Ti
Tim	-	Merchant Portion of Ti

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts %	Ms/Ts %	No	Mo	To	No/To %	Mo/To %	Tc	Ns/Tc %	Ms/Tc %	No/Tc %	Mo/Tc %	Ts/Tc %	To/Tc %
I. <u>TIME</u>																		
Daylight	A	21	7	28	75.0	25.0	42	16	58	72.4	27.6	86	24.4	8.1	48.8	18.6	32.6	67.4
Dusk	B	3	5	8	37.5	62.5	6	2	8	75.0	25.0	16	18.8	31.2	37.5	12.5	50.0	50.0
Night	C	12	14	26	46.2	53.8	2	4	6	33.3	66.7	32	37.5	43.8	6.2	12.5	81.2	18.8
	T	**36**	**26**	**62**	**58.1**	**41.9**	50	22	72	**69.4**	**30.6**	134						
	% T_A	58.3	26.9	45.2			84.0	72.7	80.6			64.2						
	% T_B	8.3	19.2	12.9			12.0	9.1	11.1			11.9						
	% T_C	33.3	53.8	41.9			4.0	18.2	8.3			23.9						
II. <u>WATCH</u>																		
Midwatch (00-04)	1	5	10	15	33.3	66.7	1	1	2	50.0	50.0	17	29.4	58.8	5.9	5.9	88.2	11.8
Morning (04-08)	2	3	6	9	33.3	66.7	6	3	9	66.7	33.3	18	16.7	33.3	33.3	16.7	50.0	50.0
Forenoon (08-12)	3	10	2	12	83.3	16.7	19	5	24	79.2	20.8	36	27.8	5.6	52.8	13.9	33.3	66.7
Afternoon (12-16)	4	7	4	11	63.6	36.4	12	10	22	54.5	45.5	33	21.2	12.1	36.4	30.3	33.3	66.7
Evening (16-20)	5	5	1	6	83.3	16.7	10	1	11	90.9	9.1	17	29.4	5.9	58.8	5.9	35.3	64.7
First (20-24)	6	6	3	9	66.7	33.3	2	2	4	50.0	50.0	13	46.2	23.1	15.4	15.4	69.2	30.8
Sea Detail	7	8	-	8	100.0	0	39	-	39	100	-	47	17.0	-	83.0	-	17.0	83.0
	T	36	26	62	58.1	41.9	50	22	72	69.4	30.6	134						
	% T_1	13.9	38.5	24.2			2.0	4.5	2.8			12.7						
	% T_2	8.3	23.1	14.5			12.0	13.6	12.5			13.4						
	% T_3	27.8	7.7	19.4			38.0	22.7	33.3			26.9						
	% T_4	19.4	15.4	17.7			24.0	45.5	30.6			24.6						
	% T_5	13.9	3.8	9.7			20.0	4.5	12.5			12.7						
	% T_6	16.7	11.5	14.5			4.0	9.1	54.2			9.7						
	% T_7	22.2	-	-			78.0	-	-			35.1						

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg %	Mg/Tg %	Too	Ti	Tin	Tim
I. TIME										
Daylight	A	25	4	29	86.2	13.8	4	119	92	27
Dusk	B	4	2	6	66.7	33.3	0	22	13	9
Night	C	6	16	22	27.3	72.7	1	55	21	34
	T	35	22	57	61.4	38.6	5	196	126	70
%	T_A	71.4	18.2	50.9			80.0	60.7	73.0	38.6
%	T_B	11.4	9.1	10.5			0	11.2	10.3	12.9
%	T_C	17.1	72.7	38.6			20.0	28.1	16.7	48.6
II. WATCH										
Midwatch (00-04)	1	0	11	11	0	100	1	29	7	22
Morning (04-08)	2	7	4	11	63.6	36.4	0	29	16	13
Forenoon (08-12)	3	9	1	10	90.0	10.0	2	48	40	8
Afternoon (12-16)	4	11	1	12	91.7	8.3	0	45	30	15
Evening (16-20)	5	4	2	6	66.7	33.3	0	23	19	4
First (20-24)	6	4	3	7	57.1	42.9	0	20	12	8
Sea Detail	7	19	-	19	100	-	1	67	67	0
	T	35	22	57	61.4	38.6	3	194	124	70
%	T_1	0	50.0	19.3			33.3	14.9	5.6	31.4
%	T_2	20.0	18.2	19.3			0	14.9	12.9	18.6
%	T_3	25.7	4.5	17.5			66.7	24.7	32.3	11.4
%	T_4	31.4	4.5	21.1			0	23.2	24.2	21.4
%	T_5	11.4	9.1	10.5			0	11.9	15.3	5.7
%	T_6	11.4	13.6	12.3			0	10.3	9.7	11.4
%	T_7	54.3	-	-			33.3	34.0	54.0	0

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts	Ms/Ts	No	Mo	To	No/To	Mo/To	Tc	Ns/Tc	Ms/Tc	No/Tc	Mo/Tc	Ts/Tc	To/Tc
					%	%				%	%		%	%	%	%	%	%
III. VISIBILITY																		
Clear, Unlimited	1	31	6	37	83.8	16.2	46	16	62	74.2	25.8	99	31.3	6.1	46.5	16.2	37.4	62.6
Slightly, Reduced	2	2	2	4	50.0	50.0	1	2	3	33.3	66.7	7	28.6	28.6	14.3	28.6	57.1	42.9
Reduced (500-2000 yds)	3	2	6	8	25.0	75.0	3	1	4	75.0	25.0	12	16.7	50.0	25.0	8.3	66.7	33.3
Poor (Under 500 yds)	4	0	12	12	0	100	0	3	3	0	100	15	0	80.0	0	20.0	80.0	20.0
	T	35	26	61	57.4	42.6	50	22	72	69.4	30.6	133						
	% T_1	88.6	23.1	60.7			32.0	72.7	86.1			74.4						
	% T_2	5.7	7.7	6.6			2.0	9.1	4.2			5.3						
	% T_3	5.7	23.1	13.1			6.0	4.5	5.6			9.0						
	% T_4	0	46.2	19.7			0	13.6	4.2			11.3						
IV. FOG																		
None	X	33	9	42	78.6	21.4	47	18	65	72.3	27.7	107	30.8	8.4	43.9	16.8	39.3	60.7
Slight Haze	1	1	0	1	100	0	1	0	1	100	0	2	50.0	0	50.0	0	50.0	50.0
Fog Patches	2	1	3	4	25.0	75.0	1	1	2	50.0	50.0	6	16.7	50.0	16.7	16.7	66.7	33.3
Dense Fog	3	0	14	14	0	100	1	2	3	33.3	66.7	17	0	82.4	7.1	11.8	82.4	17.6
	T	35	26	61	57.4	42.6	50	21	71	70.4	29.6	132						
	% T_X	94.3	34.6	68.9			94.0	85.7	91.5			81.1						
	% T_1	2.9	0	1.6			2.0	0	1.4			1.5						
	% T_2	2.9	11.5	6.6			2.0	4.8	2.8			4.5						
	% T_3	0	53.8	23.0			2.0	9.5	4.2			12.9						

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg %	Mg/Tg %	Too	Ti	Tin	Tim
III. VISIBILITY										
Clear, Unlimited	1	21	13	34	61.8	38.2	5	138	103	35
Slightly Reduced	2	4	6	10	40.0	60.0	0	17	7	10
Reduced (500-2000 yds)	3	4	2	6	66.7	33.3	0	18	9	9
Poor (Under 500 yds)	4	6	1	7	85.7	14.3	0	22	6	16
	T	35	22	57	61.4	38.6	5	195	125	70
	% T_1	60.0	59.1	59.6			100	70.8	82.4	50.0
	% T_2	11.4	27.3	17.5			0	8.7	5.6	14.3
	% T_3	11.4	9.1	10.5			0	9.2	7.2	12.9
	% T_4	17.1	4.5	12.3			0	11.3	4.8	22.9
IV. FOG										
None	X	26	19	45	57.8	42.2	5	157	111	46
Slight Haze	1	3	2	5	60.0	40.0	0	7	5	2
Fog Patches	2	2	0	2	100	0	0	8	4	4
Dense Fog	3	4	1	5	80.0	20.0	0	22	5	17
	T	35	22	57	61.4	38.6	5	194	125	69
	% T_X	74.3	86.4	78.9			100	80.9	88.8	66.7
	% T_1	8.6	9.1	8.8			0	3.6	4.0	2.9
	% T_2	5.7	0	3.5			0	4.1	3.2	5.8
	% T_3	11.4	4.5	8.8			0	11.3	4.0	24.6

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts	Ms/Ts	No	Mo	To	No/To	Mo/To	Tc	Ns/Tc	Ms/Tc	No/Tc	Mo/Tc	Ts/Tc	To/Tc
					%	%				%	%		%	%	%	%	%	%
V. PRECIPITATION																		
None	X	35	22	57	61.4	38.6	48	20	68	70.6	29.4	125	28.0	17.6	38.4	16.0	45.6	54.4
Drizzle	1	0	1	1	0	100	1	1	2	50.0	50.0	3	0	33.3	33.3	33.3	33.3	66.7
Heavy Rain	2	0	1	1	0	100	0	0	0	0	0	1	0	100	0	0	100	0
Rain Squalls	3	0	1	1	0	100	1	1	2	50.0	50.0	3	0	33.3	33.3	33.3	33.3	66.7
Snow	4	0	1	1	0	100	0	0	0	0	0	1	0	100	0	0	100	0
	T	35	26	61	57.4	42.6	50	22	72	69.4	30.6	133	26.3	19.5	37.6	16.5	45.9	54.1
	% T_X	100	84.6	93.4			96.0	90.9	94.4			94.0						
	% T_1	0	3.8	1.6			2.0	4.5	2.8			2.3						
	% T_2	0	3.8	1.6			0	0	0			.8						
	% T_3	0	3.8	1.6			2.0	4.5	2.8			2.3						
	% T_4	0	3.8	1.6			0	0	0			.8						
VI. WIND																		
Calm	0	10	16	26	38.5	61.5	13	8	21	61.9	38.1	47	21.3	34.0	27.7	17.0	55.3	44.7
1-3 Knots	1	0	0	0	0	0	2	1	3	66.7	33.3	3	0	0	66.7	33.3	0	100
4-6 Knots	2	3	3	6	50.0	50.0	1	1	2	50.0	50.0	8	37.5	37.5	12.5	12.5	75.0	25.0
7-10 Knots	3	11	5	16	68.8	31.2	12	4	16	75.0	25.0	32	34.4	15.6	37.5	12.5	50.0	50.0
11-16 Knots	4	6	1	7	85.7	13.3	12	2	14	85.7	14.3	21	28.6	4.8	57.1	9.5	33.3	66.7
17-21 Knots	5	4	0	4	100	0	3	2	5	60.0	40.0	9	44.4	0	33.3	22.2	44.4	55.6
22-27 Knots	6	1	0	1	100	0	4	0	4	100	0	5	20.0	0	80.0	0	20.0	80.0
28-33 Knots	7	0	0	0	0	0	1	1	2	50.0	50.0	2	0	0	50.0	50.0	0	100
34-40 Knots	8	0	1	1	0	100	2	2	4	50.0	50.0	5	0	20.0	40.0	40.0	20.0	80.0
Over 40 Knots	9	0	0	0	0	0	0	1	1	0	100	1	0	0	0	100	0	100
	T	35	26	61	57.4	42.6	50	22	72	69.4	30.6	133	26.3	19.5	37.6	16.5	45.9	54.1
	% T_0	28.6	61.5	42.6			26.0	36.4	29.2			35.3						
	% T_1	0	0	0			4.0	4.5	4.2			2.3						
	% T_2	8.6	11.5	9.8			2.0	4.5	2.8			6.0						
	% T_3	31.4	19.2	26.2			24.0	18.2	22.2			24.1						
	% T_4	17.1	3.8	11.5			24.0	9.1	19.4			15.8						
	% T_5	11.4	0	6.6			6.0	9.1	6.9			6.8						
	% T_6	2.9	0	1.6			8.0	0	5.6			3.8						
	% T_7	0	0	0			2.0	4.5	2.8			1.5						
	% T_8	0	3.8	1.6			4.0	9.1	5.6			3.8						
	% T_9	0	0	0			0	4.5	1.4			.8						

TABLE F-I. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg %	Mg/Tg %	Too	Ti	Tin	Tim
V. PRECIPITATION										
None	X	31	15	46	67.4	32.6	5	176	119	57
Drizzle	1	2	0	2	100	0	0	5	3	2
Heavy Rain	2	0	1	1	0	100	0	2	0	2
Rain Squalls	3	2	5	7	28.6	71.4	0	10	3	7
Snow	4	0	1	1	0	100	0	2	0	2
	T	35	22	57	61.4	38.6	5	195	125	70
	% T_X	88.6	68.2	80.7			100	90.3	95.2	81.4
	% T_1	5.7	0	3.5			0	2.6	2.4	2.9
	% T_2	0	4.5	1.8			0	1.0	0	2.9
	% T_3	5.7	22.7	12.3			0	5.1	2.4	10.0
	% T_4	0	4.5	1.8			0	1.0	0	2.9
VI. WIND										
Calm	0	15	7	22	68.2	31.8	4	73	42	31
1-3 Knots	1	0	1	1	0	100	0	4	2	2
4-6 Knots	2	4	3	7	57.1	42.9	0	15	8	7
7-10 Knots	3	2	1	3	66.7	33.3	0	35	25	10
11-16 Knots	4	4	0	4	100	0	0	25	22	3
17-21 Knots	5	3	1	4	75.0	25.0	0	13	10	3
22-27 Knots	6	3	3	6	50.0	50.0	0	11	8	3
28-33 Knots	7	2	3	5	40.0	60.0	0	7	3	4
34-40 Knots	8	1	2	3	33.3	66.7	1	9	4	5
Over 40 Knots	9	0	1	1	0	100	0	2	0	2
	T	34	22	56	60.7	39.3	5	194	124	70
	% T_0	44.1	31.8	39.3			80.0	37.6	33.9	44.3
	% T_1	0	4.5	1.8			0	2.1	1.6	2.9
	% T_2	11.8	13.6	12.5			0	7.7	6.5	10.0
	% T_3	5.9	4.5	5.4			0	18.0	20.2	14.3
	% T_4	11.8	0	7.1			0	12.9	17.7	4.3
	% T_5	8.8	4.5	7.1			0	6.7	8.1	4.3
	% T_6	8.8	13.6	10.7			0	5.7	6.5	4.3
	% T_7	5.9	13.6	8.9			0	3.6	2.4	5.7
	% T_8	2.9	9.1	5.4			20.0	4.6	3.2	7.1
	% T_9	0	4.5	1.8			0	1.0	0	2.9

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts	Ms/Ts	No	Mo	To	No/To	Mo/To	Tc	Ns/Tc	Ms/Tc	No/Tc	Mo/Tc	Ts/Tc	To/Tc
					%	%				%	%		%	%	%	%	%	%
VII. CURRENT																		
Less Than .5 Knots	0	35	19	54	64.8	35.2	36	19	55	65.5	34.5	109	32.1	17.4	33.0	17.4	49.5	50.5
.5-2.0 Knots	1	0	6	6	0	100	9	3	12	75.0	25.0	18	0	33.3	50.0	16.7	33.3	66.7
2.5-4.0 Knots	2	1	1	2	50.0	50.0	3	0	3	100	0	5	20.0	20.0	60.0	0	40.0	60.0
4.5-6.0 Knots	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Over 6.0 Knots	4	0	0	0	0	0	2	0	2	100	0	2	0	0	100	0	0	100
	T	36	26	62	58.1	41.9	50	22	72	69.4	30.6	134	26.9	19.4	37.3	16.4	46.3	53.7
	% T_0	97.2	73.1	87.1			72.0	86.4	76.4			81.3						
	% T_1	0	23.1	9.7			18.0	13.6	16.7			13.4						
	% T_2	2.8	3.8	3.2			6.0	0	4.2			3.7						
	% T_3	0	0	0			0	0	0			0						
	% T_4	0	0	0			4.0	0	2.8			1.5						
VIII. LOCATION																		
Open Sea	0	20	11	31	64.5	35.5	1	1	2	50.0	50.0	33	60.6	33.3	3.0	3.0	93.9	6.1
Restricted Passage	1	1	4	5	20.0	80.0	2	2	4	50.0	50.0	9	11.1	44.4	22.2	22.2	55.6	44.4
Approach to Port	2	2	3	5	40.0	60.0	1	2	3	33.3	66.7	8	25.0	37.5	12.5	25.0	62.5	37.5
In Ship Channel	3	4	6	10	40.0	60.0	4	1	5	80.0	20.0	15	26.7	40.0	26.7	6.7	66.7	33.3
In Harbor	4	7	2	9	77.8	22.2	17	8	25	68.0	32.0	34	20.6	5.9	50.0	23.5	26.5	73.5
Maneuver in Anchorage	5	1	0	1	100	0	1	2	3	33.3	66.7	4	25.0	0	25.0	50.0	25.0	75.0
Anchored	6	0	1	1	0	100	0	2	2	0	100	3	0	33.3	0	66.7	33.3	66.7
Underway Replenish	7	9	0	9	100	0	0	0	0	0	0	9	100	0	0	0	100	0
Approach to Stationary Object	8	0	0	0	0	0	24	5	29	82.8	17.2	29	0	0	82.8	17.2	0	100
	T	44	27	71	62.0	38.0	50	23	73	68.5	31.5	144	30.6	18.8	34.7	16.0	49.3	50.7
	% T_0	45.5	40.7	43.7			2.0	4.3	2.7			22.9						
	% T_1	2.3	14.8	7.0			4.0	8.7	5.5			6.2						
	% T_2	4.5	11.1	7.0			2.0	8.7	4.1			5.6						
	% T_3	9.1	22.2	14.1			8.0	4.3	6.8			10.4						
	% T_4	15.9	7.4	12.7			34.0	34.8	34.2			23.6						
	% T_5	2.3	0	1.4			2.0	8.7	4.1			2.8						
	% T_6	0	3.7	1.4			0	8.7	2.7			2.1						
	% T_7	20.5	0	12.7			0	0	0			6.2						
	% T_8	0	0	0			48.0	21.7	39.7			20.1						

TABLE F-1. ENVIRONMENTAL FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg	Mg/Tg	Too	Ti	Tin	Tim
					%	%				
VII. CURRENT										
Less Than .5 Knots	0	23	16	39	59.0	41.0	5	153	99	54
.5-2.0 Knots	1	9	3	12	75.0	25.0	0	30	18	12
2.5-4.0 Knots	2	3	3	6	50.0	50.0	0	11	7	4
4.5-6.0 Knots	3	0	0	0	0	0	0	0	0	0
Over 6.0 Knots	4	0	0	0	0	0	0	2	2	0
	T	35	22	57	61.4	38.6	5	196	126	70
	% T_0	65.7	72.7	68.4			100	78.1	78.6	77.1
	% T_1	25.7	13.6	21.1			0	15.3	14.3	17.1
	% T_2	8.6	13.6	10.5			0	5.6	5.6	5.7
	% T_3	0	0	0			0	0	0	0
	% T_4	0	0	0			0	1.0	1.6	0
VIII. LOCATION										
Open Sea	0	5	1	6	83.3	16.7	1	40	27	13
Restricted Passage	1	7	7	14	50.0	50.0	0	23	10	13
Approach to Port	2	0	9	9	0	100	0	17	3	14
In Ship Channel	3	13	5	18	72.2	27.8	1	34	22	12
In Harbor	4	5	1	6	83.3	16.7	1	41	30	11
Maneuver in Anchorage	5	0	2	2	0	100	0	6	2	4
Anchored	6	2	1	3	66.7	33.3	1	7	3	4
Underway Replenishment	7	0	0	0	0	0	0	9	9	0
Approach to Stationary Object	8	3	0	3	100	0	1	33	28	5
	T	35	26	61	57.4	42.6	5	210	134	76
	% T_0	14.3	3.8	9.8			20.0	19.0	20.1	17.1
	% T_1	20.0	26.9	23.0			0	11.0	7.5	17.1
	% T_2	0	34.6	14.8			0	8.1	2.2	18.4
	% T_3	37.1	19.2	29.5			20.0	16.2	16.4	15.8
	% T_4	14.3	3.8	9.8			20.0	19.5	22.4	14.5
	% T_5	0	7.7	3.3			0	2.9	1.5	5.3
	% T_6	5.7	3.8	4.9			20.0	3.3	2.2	5.3
	% T_7	0	0	0			0	4.3	6.7	0
	% T_8	8.6	0	4.9			20.0	15.7	20.9	6.6

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts %	Ms/Ts %	No	Mo	To	No/To %	Mo/To %	Tc	Ns/Tc %	Ms/Tc %	No/Tc %	Mo/Tc %	Ts/Tc %	To/Tc %
I. CONNING OFFICER																		
CO (Master)	1	11	2	13	84.6	15.4	13	6	19	68.4	31.6	32	34.4	6.2	40.6	18.8	40.6	59.4
XO (1st or 2nd Officer)	2	0	5	5	0	100	0	1	1	0	100	6	0	83.3	0	16.7	83.3	16.7
Other Qualified W.O.s	3	25	19	44	56.8	43.2	36	15	51	70.6	29.4	95	26.3	20.0	37.9	15.8	46.3	53.7
Unqualified	4	0	0	0	0	0	1	0	1	100	0	1	0	0	100	0	0	100
	T	36	26	62	58.1	41.9	50	22	72	69.4	30.6	134						
	% T_1	30.6	7.7	21.0			26.0	27.3	26.4			23.9						
	% T_2	0	19.2	8.1			0	4.5	1.4			4.5						
	% T_3	69.4	73.1	71.0			72.0	68.2	70.8			70.9						
	% T_4	0	0	0			2.0	0	1.4			.7						
II. CO (Master) on Bridge																		
Less Than 5 Minutes	1	0	2	2	0	100	0	0	0	0	0	2	0	100	0	0	100	0
6-15 Minutes	2	0	2	2	0	100	0	0	0	0	0	2	0	100	0	0	100	0
More Than 15 Minutes	3	29	19	48	60.4	39.6	46	18	64	71.9	28.1	112	25.9	17.0	41.1	16.1	42.9	57.1
Not on Bridge	4	7	3	10	70.0	30.0	4	4	8	50.0	50.0	18	38.9	16.7	22.2	22.2	55.6	44.4
	T	36	26	62	58.1	41.9	50	22	72	69.4	30.6	134	26.9	19.4	37.3	16.4	46.3	53.7
	% T_1	0	7.7	3.2			0	0	0			1.5						
	% T_2	0	7.7	3.2			0	0	0			1.5						
	% T_3	80.6	73.1	77.4			92.0	81.8	88.9			83.6						
	% T_4	19.4	11.5	16.1			8.0	18.2	11.1			13.4						

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg %	Mg/Tg %	Too	Ti	Tin	Tim
I. CONNING OFFICER										
CO (Master)	1	11	2	13	84.6	15.4	0	45	35	10
XO (1st or 2nd Officer)	2	0	7	7	0	100	0	13	0	13
Other Qualified W.O.s	3	24	12	36	66.7	33.3	5	136	90	46
Unqualified	4	0	1	1	0	100	0	2	1	1
	T	35	22	57	61.4	38.6	5	196	126	70
	% T_1	31.4	9.1	22..8			0	23.0	27.8	14.3
	% T_2	0	31.8	12.3			0	6.6	0	18.6
	% T_3	68.6	54.5	63.2			100	69.4	71.4	65.7
	% T_4	0	4.5	1.8			0	1.0	.8	1.4
II. CO (MASTER) ON BRIDGE										
Less Than 5 Minutes	1	0	0	0	0	0	0	2	0	2
6-15 Minutes	2	1	2	3	33.3	66.7	0	5	1	4
More Than 15 Minutes	3	27	16	43	62.8	37.2	3	158	105	53
Not on Bridge	4	6	4	10	60.0	40.0	1	29	18	11
	T	34	22	56	60.7	39.3	4	194	124	70
	% T_1	0	0	0			0	1.0	0	2.9
	% T_2	2.9	9.1	5.4			0	2.6	.8	5.7
	% T_3	79.4	72.7	76.8			75.0	81.4	84.7	75.7
	% T_4	17.6	18.2	17.9			25.0	14.9	14.5	15.7

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts	Ms/Ts	No	Mo	To	No/To	Mo/To	Tc	Ns/Tc	Ms/Tc	No/Tc	Mo/Tc	Ts/Tc	To/Tc
					%	%				%	%		%	%	%	%	%	%
III. PRIMARY CAUSE																		
Rules of Road	1	10	20	30	33.3	66.7	2	3	5	40.0	60.0	35	28.6	57.1	5.7	8.6	85.7	14.3
Maint. Other Ship Plot	2	0	4	4	0	100	0	0	0	0	0	4	0	100	0	0	100	0
Take Adequate Fixes	3	1	0	1	100	0	1	1	2	50.0	50.0	3	33.3	0	33.3	33.3	33.3	66.7
Inadequate Use Nav.Aids	4	0	1	1	0	100	3	3	6	50.0	50.0	7	0	14.3	42.9	42.9	14.3	85.7
Internal Ship Forces	5	2	0	2	100	0	10	1	11	90.9	9.1	13	15.4	0	76.9	7.7	15.4	84.6
External Ship Forces	6	8	0	8	100	0	22	7	29	75.9	24.1	37	21.6	0	59.5	18.9	21.6	78.4
Ground Tackle	7	1	0	1	100	0	8	4	12	66.7	33.3	13	7.7	0	61.5	30.8	7.7	92.3
Grasp of Situation	8	5	4	9	55.6	44.4	9	1	10	90.0	10.0	19	26.3	21.1	47.4	5.3	47.4	52.6
Maintain Lookout	9	1	4	5	20.0	80.0	1	1	2	50.0	50.0	7	14.3	57.1	14.3	14.3	71.4	28.6
Up-to-Date Charts	10	0	0	0	0	0	0	1	1	0	100	1	0	0	0	100	0	100
Communication Break	11	3	0	3	100	0	8	1	9	88.9	11.1	12	25.0	0	66.7	8.3	25.0	75.0
Command Leadership	12	1	0	1	100	0	2	1	3	66.7	33.3	4	25.0	0	50.0	25.0	25.0	75.0
Watch Inattention	13	7	0	7	100	0	0	0	0	0	0	7	100	0	0	0	100	0
Pilot Overreliance	14	2	2	4	50.0	50.0	7	3	10	70.0	30.0	14	14.3	14.3	50.0	21.4	28.6	71.4
Aids Overreliance	15	0	2	2	0	100	0	2	2	0	100	4	0	50.0	0	50.0	50.0	50.0
Mechanical Failure	16	6	0	6	100	0	3	1	4	75.0	25.0	10	60.0	0	30.0	10.0	60.0	40.0
Doctrine Failure	17	8	0	8	100	0	4	0	4	100	0	12	66.7	0	33.3	0	66.7	33.3
	T	55	37	92	59.8	40.2	80	30	110	72.7	27.3	202						
%	T_1	18.2	54.1	32.6			2.5	10.0	4.5			17.3						
%	T_2	0	10.8	4.3			0	0	0			2.0						
%	T_3	1.8	0	1.1			1.2	3.3	1.8			1.5						
%	T_4	0	2.7	1.1			3.8	10.0	5.5			3.5						
%	T_5	3.6	0	2.2			12.5	3.3	10.0			6.4						
%	T_6	14.5	0	8.7			27.5	23.3	26.4			18.3						
%	T_7	1.8	0	1.1			10.0	13.3	10.9			6.4						
%	T_8	9.1	10.8	9.8			11.2	3.3	9.1			9.4						
%	T_9	1.8	10.8	5.4			1.2	3.3	1.8			3.5						
%	T_{10}	0	0	0			0	3.3	.9			.5						
%	T_{11}	5.5	0	3.3			10.0	3.3	8.2			5.9						
%	T_{12}	1.8	0	1.1			2.5	3.3	2.7			2.0						
%	T_{13}	12.7	0	7.6			0	0	0			3.5						
%	T_{14}	3.6	5.4	4.3			8.8	10.0	9.1			6.9						
%	T_{15}	0	5.4	2.2			0	6.7	1.8			2.0						
%	T_{16}	10.9	0	6.5			3.8	3.3	3.6			5.0						
%	T_{17}	14.5	0	8.7			5.0	0	3.6			5.9						

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg	Mg/Tg	Too	Ti	Tin	Tim
					%	%				
III. PRIMARY CAUSE										
Rules of Road	1	0	2	2	0	100	0	37	12	25
Maintain Other Ship Plot	2	0	0	0	0	0	0	4	0	4
Take Adequate Fixes	3	11	6	17	64.7	35.3	0	20	13	7
Inadequate Use Nav. Aids	4	15	7	22	68.2	31.8	1	30	19	11
Internal Ship Forces	5	2	0	2	100	0	0	15	14	1
External Ship Forces	6	5	5	10	50.0	50.0	1	48	36	12
Ground Tackle	7	2	1	3	66.7	33.3	1	17	12	5
Grasp of Situation	8	4	6	10	40.0	60.0	1	30	19	11
Maintain Lookout	9	0	0	0	0	0	0	7	2	5
Up-to-Date Charts	10	0	1	1	0	100	0	2	0	2
Communication Break	11	3	1	4	75.0	25.0	1	17	15	2
Command Leadership	12	8	1	9	88.9	11.1	0	13	11	2
Watch Inattention	13	0	0	0	0	0	1	8	8	0
Pilot Overreliance	14	4	1	5	80.0	20.0	0	19	13	6
Aids Overreliance	15	2	2	4	50.0	50.0	0	8	2	6
Mechanical Failure	16	1	2	3	33.3	66.7	1	14	11	3
Doctrine Failure	17	6	0	6	100	0	0	18	18	0
	T	63	35	98	64.3	35.7	7	307	205	102
%	T_1	0	5.7	2.0			0	12.1	5.9	24.5
%	T_2	0	0	0			0	1.3	0	3.9
%	T_3	17.5	17.1	17.3			0	6.5	6.3	6.9
%	T_4	23.8	20.0	22.4			14.3	9.8	9.3	10.8
%	T_5	3.2	0	2.0			0	4.9	6.8	1.0
%	T_6	7.9	14.3	10.2			14.3	15.6	17.6	11.8
%	T_7	3.2	2.9	3.1			14.3	5.5	5.9	4.9
%	T_8	6.3	17.1	10.2			14.3	9.8	9.3	10.8
%	T_9	0	0	0			0	2.3	1.0	4.9
%	T_{10}	0	2.9	1.0			0	.7	0	2.0
%	T_{11}	4.8	2.9	4.1			14.3	5.5	7.3	2.0
%	T_{12}	12.7	2.9	9.2			0	4.2	5.4	2.0
%	T_{13}	0	0	0			14.3	2.6	3.9	0
%	T_{14}	6.3	2.9	5.1			0	6.2	6.3	5.9
%	T_{15}	3.2	5.7	4.1			0	2.6	1.0	5.9
%	T_{16}	1.6	5.7	3.1			14.3	4.6	5.4	2.9
%	T_{17}	9.5	0	6.1			0	5.9	8.8	0

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts	Ms/Ts	No	Mo	To	No/To	Mo/To	Tc	Ns/Tc	Ms/Tc	No/Tc	Mo/Tc	Ts/Tc	To/Tc
					%	%				%	%		%	%	%	%	%	%
IV. SECONDARY CAUSE																		
Rules of Road	1	0	2	2	0	100	1	1	2	50.0	50.0	4	0	50.0	25.0	25.0	50.0	50.0
Maint. Other Ship Plot	2	0	7	7	0	100	0	0	0	0	0	7	0	100	0	0	100	0
Take Adequate Fixes	3	1	0	1	100	0	0	1	1	0	100	2	50.0	0	0	50.0	50.0	50.0
Inadequate Use Nav.Aids	4	2	1	3	66.7	33.3	0	2	2	0	100	5	40.0	20.0	0	40.0	60.0	40.0
Internal Ship Forces	5	2	0	2	100	0	0	1	1	0	100	3	66.7	0	0	33.3	66.7	33.3
External Ship Forces	6	2	1	3	66.7	33.3	3	0	3	100	0	6	33.3	16.7	50.0	0	50.0	50.0
Ground Tackle	7	2	0	2	100	0	5	3	8	62.5	37.5	10	20.0	0	50.0	30.0	20.0	80.0
Grasp of Situation	8	3	2	5	60.0	40.0	6	1	7	85.7	14.3	12	25.0	16.7	50.0	8.3	41.7	58.3
Maintain Lookout	9	0	0	0	0	0	0	1	1	0	100	1	0	0	0	100	0	100
Up-to-Date Charts	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Communication Break	11	3	3	6	50.0	50.0	4	4	8	50.0	50.0	14	21.4	21.4	28.6	28.6	42.9	57.1
Command Leadership	12	4	0	4	100	0	5	0	5	100	0	9	44.4	0	55.6	0	44.4	55.6
Watch Inattention	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pilot Overreliance	14	0	0	0	0	0	6	2	8	75.0	25.0	8	0	0	75.0	25.0	0	100
Aids Overreliance	15	0	5	5	0	100	0	0	0	0	0	5	0	100	0	0	100	0
Mechanical Failure	16	1	3	4	25.0	75.0	3	1	4	75.0	25.0	8	12.5	37.5	37.5	12.5	50.0	50.0
Doctrine Failure	17	3	1	4	75.0	25.0	1	0	1	100	0	5	60.0	20.0	20.0	0	80.0	20.0
	T	23	25	48	47.9	52.1	34	17	51	66.7	33.3	99						
%	T_1	0	8.0	4.2			2.9	5.9	3.9			4.0						
%	T_2	0	28.0	14.6			0	0	0			7.1						
%	T_3	4.3	0	2.1			0	5.9	2.0			2.0						
%	T_4	8.7	4.0	6.2			0	11.8	3.9			5.1						
%	T_5	8.7	0	4.2			0	5.9	2.0			3.0						
%	T_6	8.7	4.0	6.2			8.8	0	5.9			6.1						
%	T_7	8.7	0	4.2			14.7	17.6	15.7			10.1						
%	T_8	13.0	8.0	10.4			17.6	5.9	13.7			12.1						
%	T_9	0	0	0			0	5.9	2.0			1.0						
%	T_{10}	0	0	0			0	0	0			0						
%	T_{11}	13.0	12.0	12.5			11.8	23.5	15.7			14.1						
%	T_{12}	17.4	0	8.3			14.7	0	9.8			9.1						
%	T_{13}	0	0	0			0	0	0			0						
%	T_{14}	0	0	0			17.6	11.8	15.7			8.1						
%	T_{15}	0	20.0	10.4			0	0	0			5.1						
%	T_{16}	4.3	12.0	8.3			8.8	5.9	7.8			8.1						
%	T_{17}	13.0	4.0	8.3			2.9	0	2.0			5.1						

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg	Mg/Tg	Too	Ti	Tin	Tim
					%	%				
IV. SECONDARY CAUSE										
Rules of Road	1	0	0	0	0	0	0	4	1	3
Maintain Other Ship Plot	2	0	0	0	0	0	0	7	0	7
Take Adequate Fixes	3	1	4	5	20.0	80.0	0	7	2	5
Inadequate Use Nav. Aids	4	5	5	10	50.0	50.0	0	15	7	8
Internal Ship Forces	5	1	0	1	100	0	0	4	3	1
External Ship Forces	6	4	2	6	66.7	33.3	0	12	9	3
Ground Tackle	7	1	1	2	50.0	50.0	1	13	9	4
Grasp of Situation	8	7	1	8	87.5	12.5	0	20	16	4
Maintain Lookout	9	0	0	0	0	0	0	1	0	1
Up-to-Date Charts	10	0	0	0	0	0	0	0	0	0
Communication Break	11	6	5	11	54.5	45.5	0	25	13	12
Command Leadership	12	3	5	8	37.5	62.5	0	17	12	5
Watch Inattention	13	0	0	0	0	0	0	0	0	0
Pilot Overreliance	14	2	0	2	100	0	1	11	9	2
Aids Overreliance	15	1	3	4	25.0	75.0	0	9	1	8
Mechanical Failure	16	0	3	3	0	100	0	11	4	7
Doctrine Failure	17	2	0	2	100	0	0	7	6	1
	T	33	29	62	53.2	46.8	2	163	92	71
%	T_1	0	0	0			0	2.5	1.1	4.2
%	T_2	0	0	0			0	4.3	0	9.9
%	T_3	3.0	13.8	8.1			0	4.3	2.2	7.0
%	T_4	15.2	17.2	16.1			0	9.2	7.6	11.3
%	T_5	3.0	0	1.6			0	2.5	3.3	1.4
%	T_6	12.1	6.9	9.7			0	7.4	9.8	4.2
%	T_7	3.0	3.4	3.2			50.0	8.0	9.8	5.6
%	T_8	21.2	3.4	12.9			0	12.3	17.4	5.6
%	T_9	0	0	0			0	.6	0	1.4
%	T_{10}	0	0	0			0	0	0	0
%	T_{11}	18.2	17.2	17.7			0	15.3	14.1	16.9
%	T_{12}	9.1	17.2	12.9			0	10.4	13.0	7.0
%	T_{13}	0	0	0			0	0	0	0
%	T_{14}	6.1	0	3.2			50.0	6.7	9.8	2.8
%	T_{15}	3.0	10.3	6.5			0	5.5	1.1	11.3
%	T_{16}	0	10.3	4.8			0	6.7	4.3	9.9
%	T_{17}	6.1	0	3.2			0	4.3	6.5	1.4

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		COLLISIONS																
		SHIPS					OTHER					TOTALS						
		Ns	Ms	Ts	Ns/Ts	Ms/Ts	No	Mo	To	No/To	Mo/To	Tc	Ns/Tc	Ms/Tc	No/Tc	Mo/Tc	Ts/Tc	To/Tc
					%	%				%	%		%	%	%	%	%	%
V. PILOT ON BOARD																		
	Yes	2	8	10	20.0	80.0	19	6	25	76.0	24.0	35	5.7	22.9	54.3	17.1	28.6	71.4
	No	34	18	52	65.4	34.6	31	16	47	66.0	34.0	99	34.3	18.2	31.3	16.2	52.5	47.5
	T	36	26	62	58.1	41.9	50	22	72	69.4	30.6	134						
	% T_Y	5.6	30.8	16.1			38.0	27.3	34.7			26.1						
	% T_N	94.4	69.2	83.9			62.0	72.7	65.3			73.9						
VI. LARGE VS. SMALL VESSEL																		
	Yes	13	11	24	54.2	45.8						24	54.2	45.8	-	-	100	-
	No	23	15	38	60.5	39.5						38	60.5	39.5	-	-	100	-
	T	36	26	62	58.1	41.9						62						
	% T_Y	36.1	42.3	38.7								38.7						
	% T_N	63.9	57.7	61.3								61.3						

TABLE F-2. HUMAN FACTORS
SHIP HANDLING ANALYSIS (continued)

VARIABLES		GROUNDINGS					OTHER	TOTAL INCIDENTS		
		Ng	Mg	Tg	Ng/Tg %	Mg/Tg %	Too	Ti	Tin	Tim
V. PILOT ON BOARD										
	Yes	10	4	14	71.4	28.6	2	51	33	18
	No	25	18	43	58.1	41.9	3	145	93	52
	T	35	22	57	61.4	38.6	5	196	126	70
	% T_Y	28.6	18.2	24.6			40.0	26.0	26.2	25.7
	% T_N	71.4	81.8	75.4			60.0	74.0	73.8	74.3
VI. LARGE VS. SMALL VESSEL										
	Yes							24	13	11
	No							38	23	15
	T							62	36	26
	% T_Y							38.7	36.1	42.3
	% T_N							61.3	63.9	57.7

Pg. 150 66%

ENVIRONMENTAL FACTORS
(NAVY)

DISTRIBUTION OF VARIABLE BY PERCENTAGE

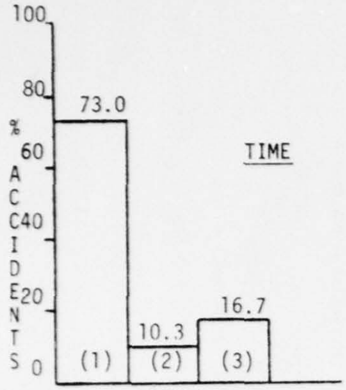


FIGURE F-1

(1) Daylight
(2) Dusk
(3) Night

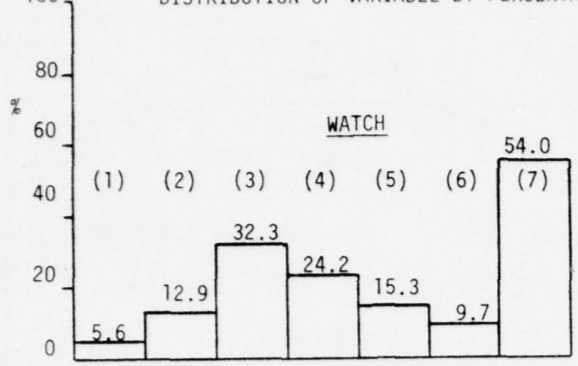


FIGURE F-2

(1) Midwatch
(2) Morning
(3) Forenoon
(4) Afternoon
(5) Evening
(6) First
(7) Sea Detail

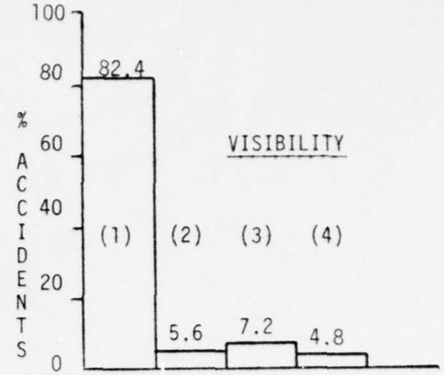


FIGURE F-3

(1) Clear, Unlimited
(2) Slightly Reduced
(3) Reduced (500-2000 Yds)
(4) Poor (Under 500 Yds)

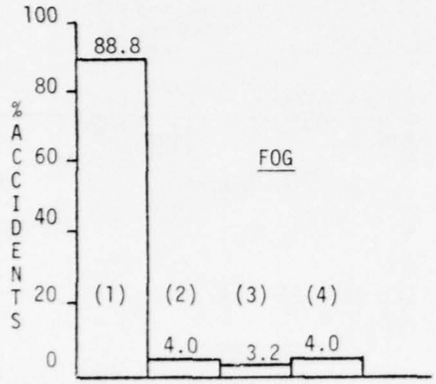


FIGURE F-4

(1) None
(2) Slight Haze
(3) Fog Patches
(4) Dense Fog

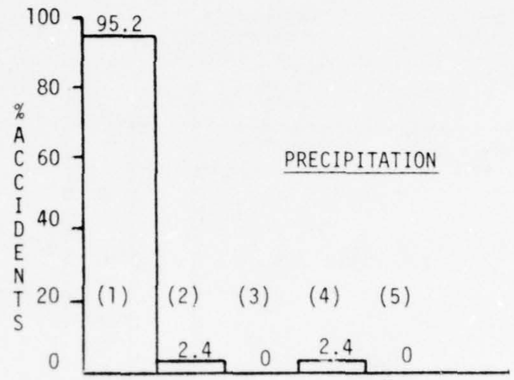


FIGURE F-5

(1) None
(2) Drizzle
(3) Heavy Rain
(4) Rain Squalls
(5) Snow

ENVIRONMENTAL FACTORS
(NAVY)

DISTRIBUTION OF VARIABLE BY PERCENTAGE

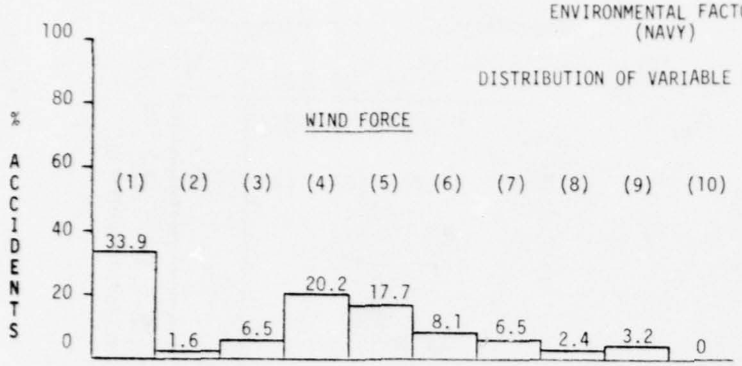


FIGURE F-6

(1) Calm
(2) 1-3 Knots
(3) 4-6 Knots
(4) 7-10 Knots
(5) 11-16 Knots
(6) 17-21 Knots
(7) 22-27 Knots
(8) 28-33 Knots
(9) 34-40 Knots
(10) Over 40 Knots

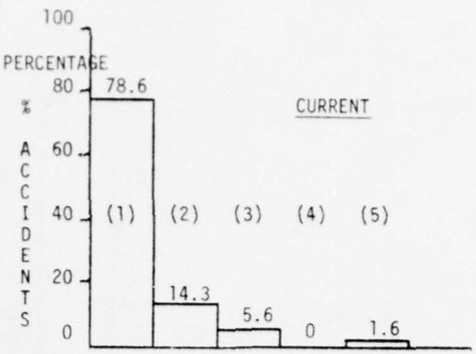


FIGURE F-7

(1) Less Than .5 Knots
(2) .5-2 Knots
(3) 2.5-4 Knots
(4) 4.5-6 Knots
(5) Over 6 Knots

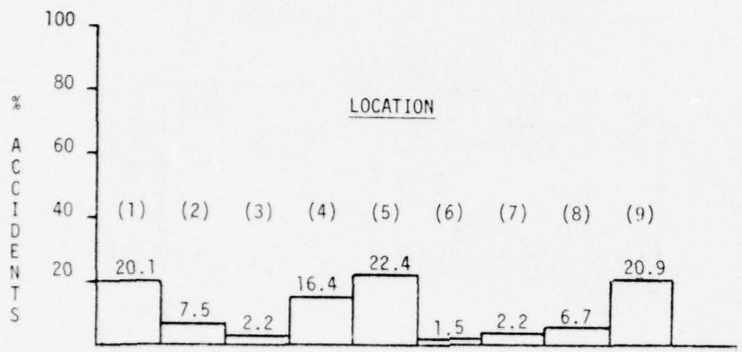


FIGURE F-8

(1) Open Sea
(2) Restricted Passage
(3) Approach to Port
(4) In Ship Channel
(5) In Harbor
(6) Maneuver in Anchorage
(7) Anchored
(8) Underway Replenishment
(9) Approach to Stationary Objects

HUMAN FACTORS
(NAVY)
DISTRIBUTION OF VARIABLE BY
PERCENTAGE

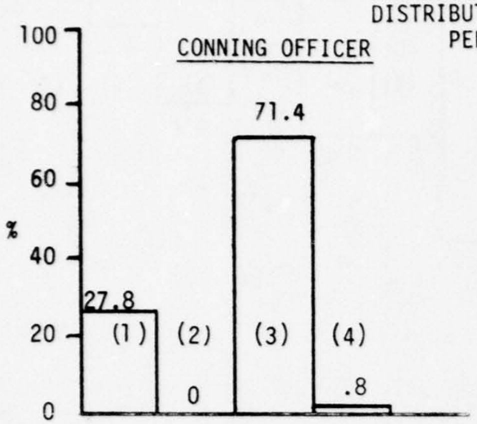


FIGURE F-9

(1) CO (MASTER)
(2) XO (1st or 2nd OFFICER)
(3) OTHER QUALIFIED WATCH OFFICERS
(4) UNQUALIFIED

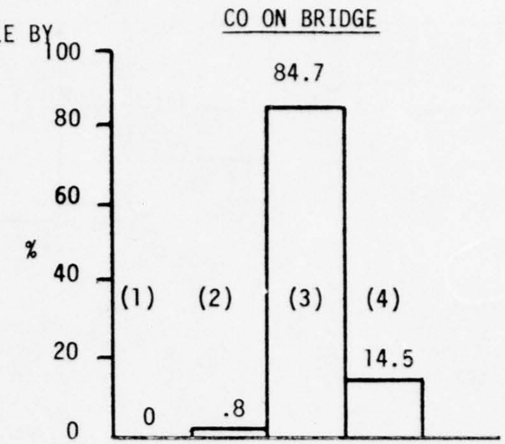


FIGURE F-10

(1) LESS THAN 5 MINUTES
(2) 6 - 15 MINUTES
(3) MORE THAN 15 MINUTES
(4) NOT ON BRIDGE

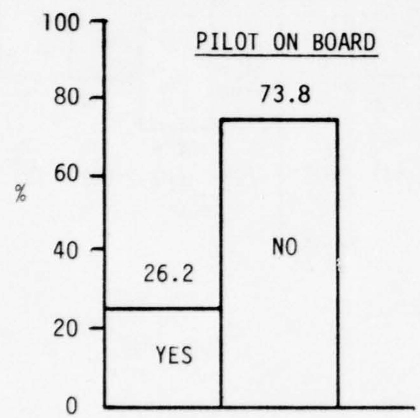


FIGURE F-11

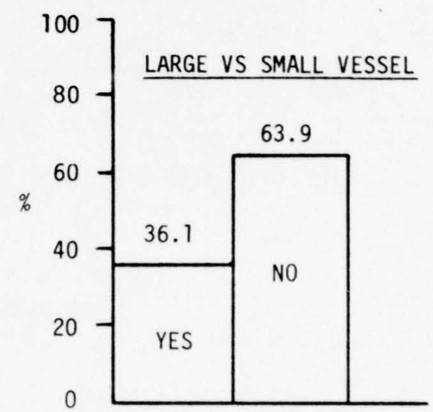


FIGURE F-12

HUMAN FACTORS
(NAVY)
DISTRIBUTION OF VARIABLE BY PERCENTAGE

PRIMARY CAUSE

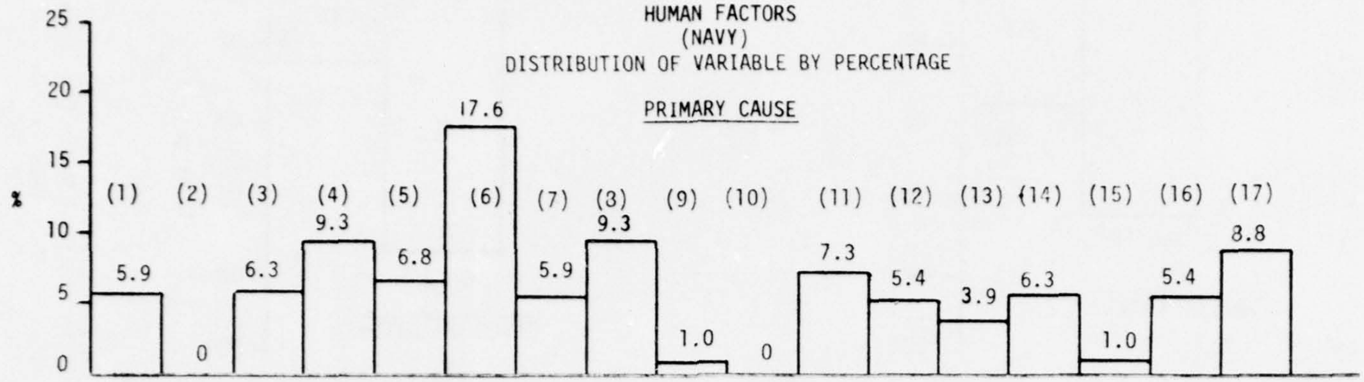


FIGURE F-13

(1) RULES OF THE ROAD
(2) FAILURE TO MAINTAIN ADEQUATE PLOT
(3) FAILURE TO TAKE ADEQUATE FIXES
(4) INADEQUATE USE OF NAVIGATION AIDS
(5) INTERNAL FORCES ON SHIP
(6) EXTERNAL FORCES ON SHIP
(7) IMPROPER USE OF GROUND TACKLE
(8) FAILURE TO GRASP SITUATION
(9) FAILURE TO MAINTAIN LOOKOUT
(10) FAILURE TO MAINTAIN CHARTS
(11) COMMUNICATION BREAKDOWN
(12) LACK OF COMMAND LEADERSHIP
(13) INATTENTIVE WATCH PERSONNEL
(14) OVERRELIANCE ON PILOT
(15) OVERRELIANCE ON AIDS
(16) MECHANICAL FAILURE
(17) FAILURE TO COMPLY WITH DOCTRINE

SECONDARY CAUSE

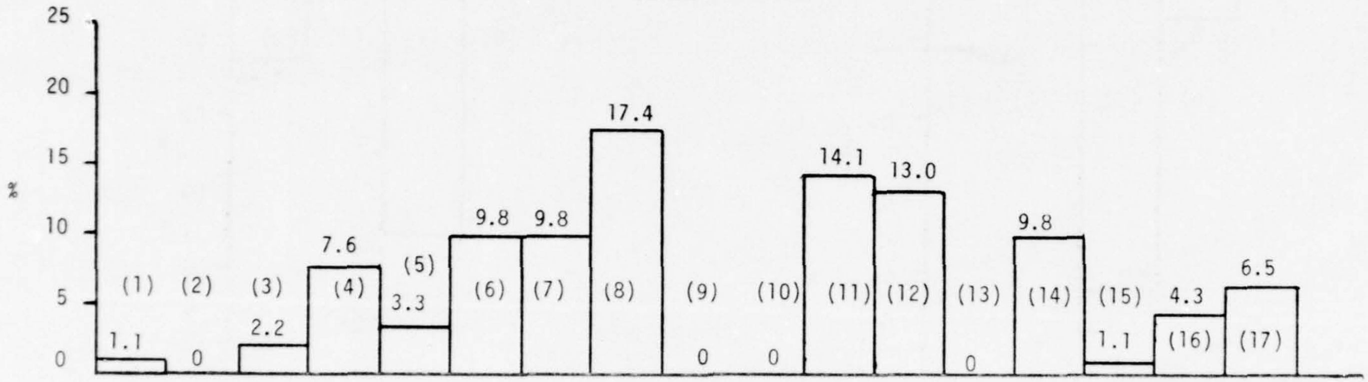


FIGURE F-14

APPENDIX G

TOTAL RESEARCHED ENVIRONMENTAL FACTORS

APPENDIX G

TOTAL RESEARCHED ENVIRONMENTAL FACTORS

TIME	A	DAYLIGHT		
	B	DUSK		
	C	NIGHT		
WATCH	1	MIDWATCH (00-04)		
	2	MORNING (04-08)		
	3	FORENOON (08-12)		
	4	AFTERNOON (12-16)		
	5	EVENING (16-20)		
	6	FIRST (20-24)		
	7	SEA DETAIL		
VISIBILITY	1	CLEAR UNLIMITED		
	2	SLIGHTLY REDUCED		
	3	REDUCED (500-2000 Yds)		
	4	POOR (UNDER 500 Yds)		
FOG	X	NONE		
	1	SLIGHT HAZE		
	2	FOG PATCHES		
	3	DENSE FOG		
PRECIPITATION	X	NONE		
	1	DRIZZLE		
	2	HEAVY RAIN		
WIND		FORCE		DIRECTION FROM WHICH BLOWING
(FORCE-	0	CALM	1	AHEAD
DIRECTION)	1	1-3 kts	2	STARBOARD BOW
	2	4-6 kts	3	STARBOARD BEAM
	3	7-10 kts	4	STARBOARD QUARTER
	4	11-16 kts	5	ASTERN
	5	17-21 kts	6	PORT QUARTER
	6	22-27 kts	7	PORT BEAM
	7	28-33 kts	8	PORT BOW
	8	34-40 kts		
	9	OVER 40 kts		
CURRENT	0	LESS THAN 0.5 kt		DIRECTION FROM WHICH FLOWING
(FORCE-	1	0.5 to 2 kts	1	AHEAD
DIRECTION)	2	2.5 to 4 kts	2	STARBOARD BOW
	3	4.5 to 6 kts	3	STARBOARD BEAM
	4	OVER 6 kts	4	STARBOARD QUARTER
			5	ASTERN
			6	PORT QUARTER
			7	PORT BEAM
			8	PORT BOW

LOCATION (MORE THAN ONE NUMBER MAY BE USED)	0	OPEN SEA
	1	RESTRICTED PASSAGE
	2	APPROACH TO PORT
	3	IN SHIP CHANNEL
	4	IN HARBOR
	5	MANEUVERING IN ANCHORAGE
	6	ANCHORED
	7	UNDERWAY REPLENISHMENT
	8	MAKING APPROACH TO STATIONARY OBJECT

APPENDIX H

TOTAL RESEARCHED HUMAN FACTORS

APPENDIX H

TOTAL RESEARCHED HUMAN FACTORS

CONNING OFFICER
1 CO (MASTER)
2 XO (FIRST OR SECOND OFFICER)
3 OTHER QUALIFIED WATCH OFFICER
4 UNQUALIFIED OFFICER

CONNING OFFICER EXPERIENCE
1 LESS THAN TWO YEARS
2 2 - 8 YEARS
3 MORE THAN 8 YEARS

CO (MASTER) ON BRIDGE
1 LESS THAN 5 MINUTES BEFORE INCIDENT
2 6 - 15 MINUTES BEFORE INCIDENT
3 MORE THAN 15 MINUTES BEFORE INCIDENT
4 NOT ON BRIDGE

PRIMARY CAUSE(S) (MORE THAN ONE MAY BE DESIGNATED)
1 FAILURE TO OBSERVE RULES OF THE ROAD
2 FAILURE TO MAINTAIN ADEQUATE PLOT (BEARINGS) OF OTHER SHIP
3 FAILURE TO TAKE ADEQUATE FIXES
4 FAILURE TO MAKE ADEQUATE USE OF AIDS TO NAVIGATION
5 FAILURE TO COMPENSATE FOR INTERNAL FORCES ACTING ON SHIP
6 FAILURE TO COMPENSATE FOR EXTERNAL FORCES ACTING ON SHIP
7 FAILURE TO USE GROUND TACKLE PROPERLY
8 FAILURE TO GRASP THE SIGNIFICANCE OF THE SITUATION
9 FAILURE TO MAINTAIN ADEQUATE LOOKOUT
10 FAILURE TO MAINTAIN UP-TO-DATE CHARTS
11 COMMUNICATIONS BREAKDOWN
12 LACK OF COMMAND LEADERSHIP
13 INATTENTION ON THE PART OF WATCH PERSONNEL (NOT CONNING OFFICER)
14 OVERRELIANCE ON PILOT
15 OVERRELIANCE ON AIDS
16 MECHANICAL FAILURE
17 FAILURE TO FOLLOW ESTABLISHED DOCTRINE

SECONDARY CAUSE(S) (MORE THAN ONE MAY BE DESIGNATED)
1 FAILURE TO OBSERVE RULES OF THE ROAD
2 FAILURE TO MAINTAIN ADEQUATE PLOT (BEARINGS) OF OTHER SHIP
3 FAILURE TO TAKE ADEQUATE FIXES
4 FAILURE TO MAKE ADEQUATE USE OF AIDS TO NAVIGATION
5 FAILURE TO COMPENSATE FOR INTERNAL FORCES ACTING ON SHIP
6 FAILURE TO COMPENSATE FOR EXTERNAL FORCES ACTING ON SHIP
7 FAILURE TO USE GROUND TACKLE PROPERLY
8 FAILURE TO GRASP THE SIGNIFICANCE OF THE SITUATION
9 FAILURE TO MAINTAIN ADEQUATE LOOKOUT
10 FAILURE TO MAINTAIN UP-TO-DATE CHARTS
11 COMMUNICATIONS BREAKDOWN
12 LACK OF COMMAND LEADERSHIP

13 INATTENTION ON THE PART OF WATCH PERSONNEL (NOT CONNING OFFICER)
14 OVERRELIANCE ON PILOT
15 OVERRELIANCE ON AIDS
16 MECHANICAL FAILURE
17 FAILURE TO FOLLOW ESTABLISHED DOCTRINE

PILOT ON BOARD
1 YES
2 NO

LARGE VS SMALL VESSEL
1 YES
2 NO

APPENDIX I

PROPOSED TRAINING AIDS AND DEVICES, FUNCTIONAL DESCRIPTIONS

APPENDIX I

PROPOSED TRAINING AIDS AND DEVICES, FUNCTIONAL DESCRIPTIONS

RULES OF THE ROAD TRAINING DEVICE

The difficulty in translating the written word to visual experience makes this device necessary. Determination of the course of an aircraft carrier, or the target angle of a merchant vessel at night is crucial in an evaluation of the situation, hence dictates the governing rules. The proposed device is to be designed as a part-task trainer which will facilitate the recognition of situations as well as test the proficiency of a prospective conning officer.

A minimum of three rectangular enclosures with top, bottom, and three sides are required. Each enclosure is to have an open front. The size of the enclosure will be determined by the size of the largest model used therein. The front of the classroom is always considered to be north, and the trainee, looking to the center front of the room, is facing north. Own ship is always on a northerly course; therefore, the orientation of the enclosure to the front-rear axis of the room determines the bearing of the target vessel from own ship.

Rheostatically controlled lighting will be provided so that the environmental conditions can be varied from daylight to darkness. The base or bottom is to represent the sea, the sides the sky, and the joining line between the base and sides represents the horizon. In the top of the enclosure are to be a series of three opaque screens which can be lowered in front of the models to simulate various conditions of haze and give the impression of distance. In the center of the enclosure is to be a single electrical connection into which a ship model is to be inserted. This connection will be capable of being rotated a full 360^{o}, but no more. All power to the enclosure will come from an instructor's console. The enclosures are to be portable on a dolly and capable of being moved through a 76cm door. Height of the enclosures should be in accordance with the eye height of the 95th percentile man in a sitting position.

A minimum of five ship models are required although more would be beneficial. Each model is to be a stylized version of a specific ship class. The following classes are considered to be absolutely necessary: an aircraft carrier, a destroyer or cruiser type, a tanker, a freighter, and a small coastal fishing vessel. Each model is to be equipped with the required running lights properly placed. Change of model lights and intensity will be under instructor control at the console. Models are to be scaled, but different models need not be of the same scale. All models will have appropriate side openings; i.e., portholes, doors, and

ventilators, with relatively weak lights behind the openings. Deck lighting will be available. Lighting intensity will be scaled with the standard being the masthead light. Eight kilometers visibility with the enclosure unscreened will equate to 15 meters. The model will be fixed to the rotatable electrical connection in the base of the enclosure. Control of the model rotation will originate at the instructor's console. Models will have identical, quick release type plugs so that any model may be inserted in any enclosure. Interchange of models should take no longer than 1 minute. The coastal fishing vessel model is to have two booms which can be manually rotated 90° from the fore and aft axis of the vessel to simulate a trawler with nets streamed.

The portable instructor's console will be designed so that one instructor can control up to five enclosures simultaneously. The following capabilities are required at the instructor's console:

Vessel light control; i.e., number, placement, and color

Vessel heading

External lighting conditions

Degree of haze as determined by the opaque screen(s) in use

Deck lighting, both intensity and amount.

Change of any of the above variables will be performable within 1 minute. Power for the console and the remote enclosures and models will be from a standard 60 Hz 120v power source.

Lighting conditions and model heading will be indicated at the instructor's console. The concept of use is that three to five enclosures will be strategically placed in an arc around the perimeter of a classroom. Each enclosure will contain one model. Students will view each vessel under varying conditions of environment and receive instruction commensurate with the learning level. Then, using a predetermined script, trainees will be tested on their knowledge of the rules of the road by being required to identify:

Type and steaming condition of the vessel

Target angle and course

When applicable, vessel mission

Rules which apply for the existing situation.

GROUND TACKLE TRAINING DEVICE

This device will be used as a part-task trainer which consists of a stylized mock-up of a vessel with 3 anchors (2 forward and 1 aft), 1 wildcat, 5 capstans, a bullnose, 2 hawse pipes, and the necessary stoppers. It is not necessary to have powered equipment although all elements must be capable of being hand operated.

The model should be between 2 and 3.5 meters in length. It will be on a movable platform so that it can be easily maneuvered by a single instructor in a classroom of students. The device must be capable of passing through a standard classroom door. The anchor chain will be stored in a chain locker and approximately scaled to the size of the anchor. It will have detachable links at all proper locations. The chain will be correctly marked. Two complete scaled sets of mooring lines and two scaled wire ropes will be available. Bits, cleats, and chocks are required.

In addition, two stylized unpowered mock-ups of tugs (YTB's) are required. It is not required that the equipment on these tugs be operable. They require three lines on each model so that the instructor can demonstrate the make-up of tugs to a ship.

BRIDGE SIMULATOR

The bridge simulator is designed to provide systems training covering ship handling and conning situations over a wide range of conditions. The basic requirements are derived from sections II and III of this report; however, it is imperative that proposed designs of newer vessels such as hydrofoils and surface effect ships be considered. The following discussion addresses ships currently in the inventory and ships scheduled to come in to the inventory. The simulator must include all necessary provisions (interface, computer capacity, instructor console, etc.) for the addition of two additional bridge stations of advanced design vessels. The building accommodating the simulator should be of sufficient size to include the addition of these two additional bridge stations.

Despite the fact that some of the survey respondents to questions concerning a simulator stated a desire for a motion platform, this has not been classed as a requirement. It would be nice to have, but considering the cost vs. benefits, it is unwarranted. Real time simulation is required. A reset capability is needed. A concept formulation analysis based on a study of the Computer Aided Operational Research Facility at King's Point, New York, is recommended prior to the preparation of a request for proposal. Consideration should be given to the use of stimulated vice simulated equipment.

The device is to have two bridge stations which can be operated simultaneously in an independent and dependent mode. Bridge equipment which pertains to navigation, piloting, and conning will duplicate that found on a CG. Other equipment, such as sonar repeaters and fire control equipment, need not be present, or if it is, should be stylized mock-ups. Internal communications will consist of sound powered telephones and the appropriate MC's. Built-in test equipment (BITE) is required.

Adjacent to and connected with each bridge a small space is required which simulates the navigational plotting area. This space need be furnished only with a plotting table equipped with the necessary plotting equipment and communications equipment connected to the bridge and the simulated CIC.

A second space is needed which simulates CIC. Since the device is designed as a ship handling trainer, only that equipment and communications associated with navigation and piloting and formation steaming are required. This space need not be adjacent to or connected with the bridge.

An instructor's console is required which has the capability of:

1. Responding to engine and steering orders
2. Simulating commands external to the own ship bridge
3. Independent control of other ships
4. Inserting and correcting simulated casualties
5. Acting as alternate steering stations, the signal bridge, and other ship stations not actually manned
6. Setting up and controlling the problem for all operating stations to include independent control of all environmental factors
7. Monitoring the progress of the problem. A video tape of the problem as it progresses is not required although a tape recorder may be needed to monitor voice communications.

The visual scene which is observed by the trainee on the bridge should encompass 360^{o}; however, 270^{o} is the minimum acceptable arc. Should 270^{o} be made available, the visual scene will have the capability of being rotated 90^{o} to the left or right to permit docking and going alongside another vessel.

The visual presentation will include:

1. A minimum of four other simulated ships
2. The relative location of the other bridge mock-up when the two are acting dependently
3. A harbor, from 10 kilometers beyond the sea buoy to and including a dock

4. The capability of approaching a stationary object or other ship to a distance of 10 meters
5. Relative motion of all observable objects as would be seen by the OOD
6. Within and outside of the actual harbor, an area designated as an anchorage which includes mooring buoys
7. A beach area suitable for beaching landing ships
8. Environmental effects to include day/night, fog, rain, and snow. These effects are to be independently variable.
9. Coordination of the visual scene with the electronic returns.

NEW SMALL CRAFT TRAINER

A new class of small craft training device is proposed which would have the following characteristics.

1. Length overall 22m not to exceed 25m. Minimum possible draft.
2. Three propellers each connected to a separate diesel engine. No cross-connect capability is required or desired.
3. Propeller guards extending beneath the actual propellers.
4. Either twin rudders or a single rudder is acceptable. Rudder guards similar to propeller guards are required.
5. A single generator of adequate size to provide all necessary electrical power. This generator is to be driven by one of the aforementioned diesel engines when that engine is not connected to the propeller shaft. Thus each engine must have the capability of driving either a propeller or the generator, but not both simultaneously.
6. The craft is to be operated as a twin screw or single screw vessel. Three propellers are necessary with one being on the centerline.
7. Three anchors are required, two forward and one aft.
8. One wildcat and a capstan are required forward and one capstan aft.
9. Height of the flying bridge from the waterline should be at least 5 meters.
10. A deck house is required extending from aft of the wildcat to within approximately 5 meters of the stern. The deck house is to contain two modified CIC's. Equipment in each CIC will comprise a gyro repeater, radar repeater, fathometer repeater, 1 DRT, sound powered communications, and a remote radio transceiver.

11. The pilot house will be forward on the 02 level. It will contain standard ship control equipment, a plotting table, a fathometer, one VHF/UHF transceiver, standard harbor navigation equipment, and a nonsophisticated, commercial grade radar with a maximum required range of 20 kilometers.
12. The flying bridge will be above the pilot house and in communication with it, CIC, the engine room, the forecastle, and the fantail by sound powered telephone. In addition, there will be voice tube communications between the flying bridge, pilot house, and the engine room. A gyro repeater is required on the centerline at the forward point of the flying bridge with two additional repeaters slightly aft and on the port and starboard sides of the bridge.
13. The signal bridge will be on the same level as the flying bridge, but aft. The combination signal bridge/flying bridge will cover at least 50 percent of the deck house. Sound powered communications are necessary between the signal bridge, flying bridge, and CIC.
14. No food preparation, berthing, or refrigeration space is required.
15. Storage tanks for fuel and fresh water are required.
16. No hot water is necessary; however, there will be a requirement to heat the enclosed area. Air conditioning is not required. Deck ventilators and wind scoops will be needed.
17. There is a requirement for male and female lavatory facilities.
18. A boatswain's locker for the storage of lines, seamanship equipment, and miscellaneous gear is necessary.
19. No maintenance is to be performed underway.
20. All support facilities are to be ashore.
21. Individual ship classes have different operating characteristics. It is anticipated that these differences will be provided for by instructions given to the helmsman and engine operating personnel.
22. A remote engine control in the pilot house should be considered. However, the capability of changing operating mode; i.e., single to twin screw and vice versa, is not required outside of the engineering spaces.
23. An electrical switchboard may be required. An internal communications switchboard is not required.
24. Hull material will be a reinforced lightweight fiberglass, or equivalent.

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